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Power Plant ENGINEERING

THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

SEPTEMBER • 1946

Features

6 YEARS AT 600 LB • COAL HANDLING CONTROL • MOTORIZED CONTROL VALVES • VERTICAL PUMP CORROSION • MAINTAINING LUBRICATING OILS • SERIES CAPACITOR PROTECTION • WEST POINT WATER CONDITIONING • ATOMICS • CONTENTS PAGE 5

THIS ELLIOTT
TURBINE-GENERATOR

together with other improvements has permitted a saving of at least 7000 tons of coal per year at the plant of Libbey-Owens-Ford Glass Company, Rossford, Ohio. The modernization project was planned and carried out by Stone & Webster Engineering Corporation, under the direction of Mr. D. H. Goodwillie, Executive Vice-President, Mr. C. L. Drake, Director of Engineering, and Mr. W. H. Hasselbach, Chief Engineer of Libbey-Owens-Ford Glass Company.

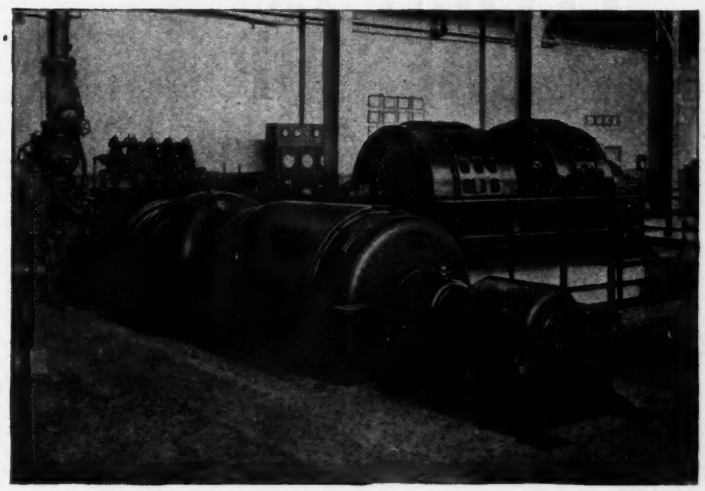
ELLIOTT

modernization · · *justified by its big potential savings*

Seven thousand tons yearly is a lot of coal. As a wartime saving it bulked far larger than the necessary critical materials and labor required to provide the new Elliott turbine-generator which, it was expected, would effect the economy. So, late in 1944, even while hostilities were "hitting on all eight", the War Production Board gave the go-ahead signal for the building and installation of this 2500-kw Elliott automatic extraction turbine-generator unit, in the Rossford, Ohio, plant of Libbey-Owens-Ford Glass Company. Engineering design and construction were conducted by Stone & Webster Engineering Corporation, Boston.

One side-light on this modernization job is of interest. The installation had been contemplated originally on the basis of a 2000-kw Elliott unit, the order given in 1941 and fabrication already begun, when war strictures intervened. By the time the order was released, power requirements had jumped to 2500-kw and process steam demand had increased. Because of the generous design of the partially completed Elliott unit, it was possible with some alterations, to increase its capacity as required by the new conditions.

The unit is now installed, and operating fully as expected. Demonstrating that the economy characteristics of Elliott turbine-generators are based upon sound engineering.



The new Elliott 2500-kw automatic extraction turbine-generator seen from the generator end. The turbine operates on 400-psi, 750 F steam, with extraction at 185 psi, 620 F to process.

H-697

Company

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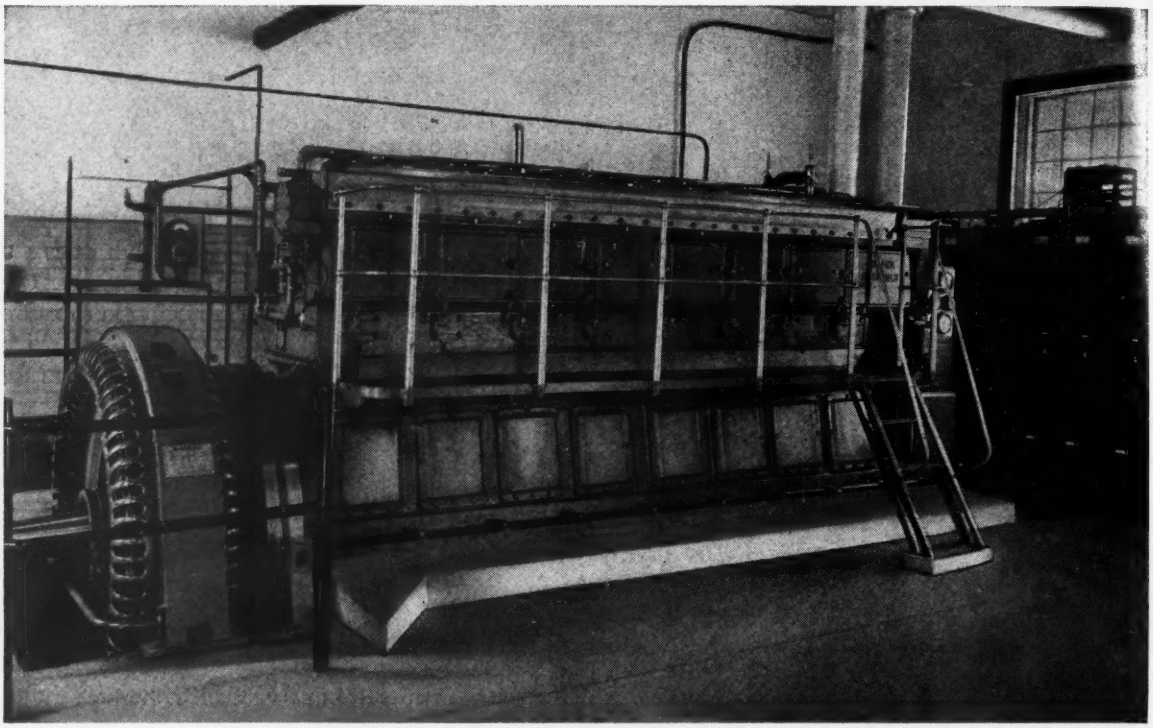

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Power Plant ENGINEERING

September, 1946

VOLUME 50—NUMBER 9

Cover: 250 kva steam turbine-generator in the attractively arranged power plant of Armstrong Paint and Varnish Works, Chicago.

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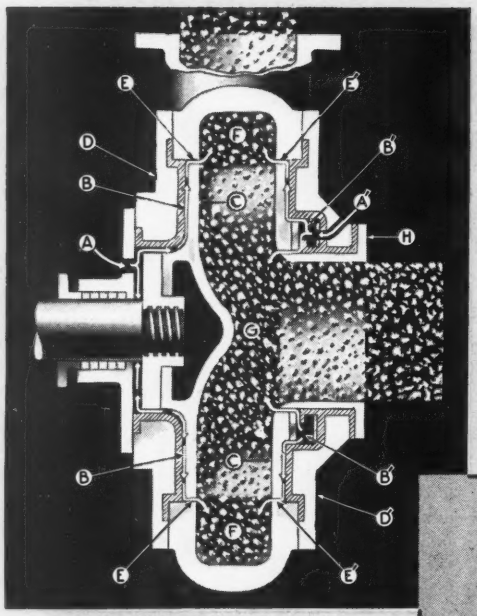
HYDROSEAL PRINCIPLE AND MAXIMIX PROTECTION

Arrows indicate hydrosealing flow and crosshatching indicates replaceable liner parts.

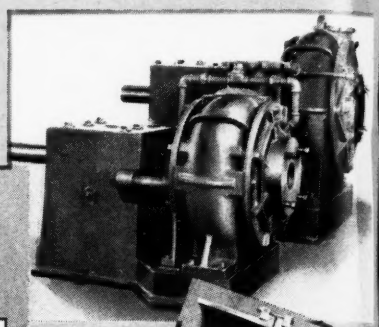
Controlled flow of small quantities of clear water or other solution free from grit is introduced at A and A′; passes through the annular clearances B and B′; between both sides of rotating impeller C and the stationary pump side plates D and D′; over the periphery E and E′ entirely around each side of the impeller and into the volute F, where it mixes with abrasive-laden water. Also flowing from the annular clearance B′ into the suction eye G of the impeller, entirely around the periphery of the suction sleeve H. Abrasives laden water passes through the suction sleeve H, is drawn into the impeller C, passes around the volute F, and out through the discharge. The impeller and shell are made of abrasive resistant alloys best suited for the conditions.

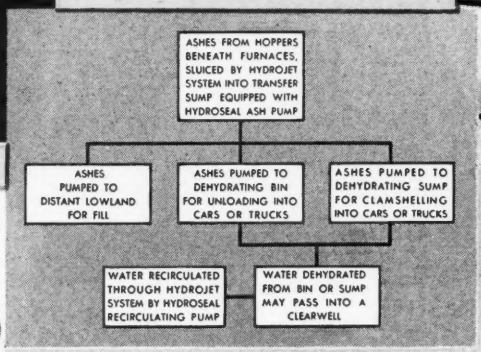


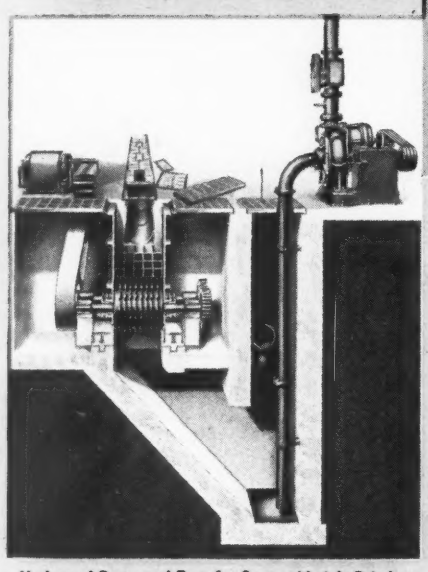
RIGHT—Hydroseal Ash Pumps.

BELOW—Flow Chart showing versatility of pumping ashes to disposal.

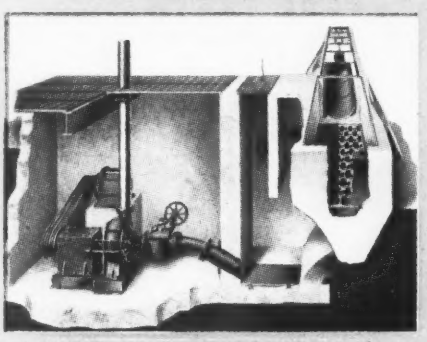
LOWER RIGHT—Methods of joining lengths of hard, abrasion resistant Ashcolite Pipe.




ASHES FROM HOPPERS BENEATH FURNACES, SLUICED BY HYDROJET SYSTEM INTO TRANSFER SUMP EQUIPPED WITH HYDROSEAL ASH PUMP
ASHES PUMPED TO DISTANT LOWLAND FOR FILL
ASHES PUMPED TO DEHYDRATING BIN FOR UNLOADING INTO CARS OR TRUCKS
ASHES PUMPED TO DEHYDRATING SUMP FOR CLAMSHELLING INTO CARS OR TRUCKS
WATER RECIRCULATED THROUGH HYDROJET SYSTEM BY HYDROSEAL RECIRCULATING PUMP
WATER DEHYDRATED FROM BIN OR SUMP MAY PASS INTO A CLEARWELL



Hydroseal Pump and Transfer Sump with Ash Grinder for reducing oversize for pumping.



Hydroseal Pump in dry well alongside Transfer Sump, so pump is always primed.

PIONEERING OUR IDEA OF "PUMP YOUR ASHES"

In the early days of the Hydrojet System, ashes were sluiced to the nearest point of disposal (fill or storage sump) and in some installations this would be quite a distance from the power plant. It soon became obvious to us and to America's leading power plant and consulting engineers who co-operated with us, that pumping offered the easiest, quickest, cleanest and cheapest means of ash disposal (see chart above). To do this with economy and reliability meant that a pump had to be designed for this severe service. The Hydroseal Pump with Maximix Rubber Bell Liners was developed by us (see description and cross section drawing above); now hundreds are used in this service, and in metal and non-metallic mines throughout the world. A special pipe was needed for handling this highly abrasive material, so we developed Ashcolite. . . . Catalogs on request; and remember *"As always, A-S-H will pioneer in ash and dust handling."*

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Front Lines

FRONT LINES has previously reported on the studies made of fish noises; but that was during the war when very little could be said about them. Such investigations were made primarily in connection with the development of underwater acoustic equipment by the Navy—listening devices, submarine detecting gear, mine mechanisms and homing torpedoes. In developing these devices, "foreign" noises that might affect them had to be analyzed, and it was found that many of these noises were made by fish. Most of the noise was caused by croakers, members of the drumfish family, which produce a rapid drum roll, giving the effect of an electric drill being driven into asphalt and audible under water as much as 25 ft from the source. The toadfish, a sluggish, ill-tempered, nest-building, bottom dweller, produces a much more intense noise than any other form of marine life investigated. This is a low-pitched musical blast of about one-half second duration, somewhat like a boat whistle. The hogfish makes a grunting noise by gnashing his teeth; the spot makes a series of raucous honks; the sea robin, a rhythmic squawk, squeal or cackle; and the sea catfish, a drumming noise like the beating of a tom-tom. Complete technical details of these were recently reported by Milton B. Dobrin of the Acoustics Division of the Naval Ordnance Laboratory, before a recent convention of the AAAS.

Editor's Note—To amateur psychologists and psychiatrists. In case you are looking for the deep, sinister significance of Front Lines' preoccupation with fish, such as fish noises and pumping fish and the other references we have made, you can save yourself a lot of time. We know what lies at the source of this obsession. It is simply this: the Front Lines editor, brought up on the Atlantic Coast where fish not only look and smell like fish but also taste like fish, has never been able to accustom himself to the tasteless, flabby tissue that is served to him under the name of fish in this city. Since he cannot eat the fish he can get, the psychological reaction is perfectly clear.

THE RADIO-ACTIVE HORSE may be one of the interesting by-products of the current work on atomic energy. This horse doesn't yet exist but there is a very good possibility that he may develop in the near future. This isn't a gag, but definitely a serious project, for the following reasons. As everybody knows, serum and anti-toxins used on human beings are made from certain glandular secretions of horses. We know that these serums and anti-toxins work on human beings, because they usually produce the results desired. But we do not know exactly *how* they do this. We do not know exactly what path these serums take in the human body when injected into it. But one of the interesting by-products of atomic operations is the production of a new isotope of carbon known as Carbon 14. This is radio-active. If we could make a serum containing small amounts of this Carbon 14 and inject it into human beings, we might be able to determine just where the serum goes in order to do the work that it does and make it work even better. Accordingly, if we could feed a horse radio-active oats and radio-active water and produce from him a serum containing a very small amount of radio-active Carbon 14. . . . Don't laugh too hard yet. You may live to see stranger things.

THAT REASONABLY good Diesel fuel quality pays dividends is indicated by tests covering a good cross-section of present day engine construction. Beyond this point, however, there is little to be gained and the most promising means of improving engine performance is in the hands of the engine designer and builder. These are the conclusions of W. S. Mount and G. A. Hope in a recent paper on Relation of Diesel Fuel Properties to Their Engine Performance. The determination of suitable fuel characteristics for the modern high speed Diesel engine resolves itself into two basic problems. 1, That involving engine life and maintenance costs—both studied most satisfactorily in the field; 2, Engine performance as evidenced immediately after the fuel is put into the engine.

GREAT GROW THE GASES is the title of a Cinderella story told by the API. Cinderella in this case goes under the name Natural Gas. The wicked sisters are Neglected Opportunity and Didn't Know. The fairy godmother is Industrial Research and the handsome prince is Hydrocarbon Chemistry. The glass slipper—well, anyhow, you get the idea! It is really three stories in one—natural gas, natural gasoline, and liquefied petroleum gases—told together because their histories are strangely parallel. All were once waste products, unwanted nuisances that had to be disposed of somehow. But men of vision and patience unlocked the secrets of their worth and curbed their eccentricities. As a result, all three today make a great and growing contribution to American living.

EVERY ONCE in a while somebody brings up the subject of inventions that have been made but which we haven't yet got, for some reason or other. Not long ago, W. A. S. Douglas called attention to some of these. He discussed the reports that the everlasting match was bought up and shelved some years ago by Kreuger, the Swedish match king, in order to save his match industry. Another idea is that for a perpetual depilatory. Still another is the electric light bulb with 3 filaments, only one of which will burn at a time, a switchover device selecting each one as its predecessor burns out. Then there is the electric torch that can be recharged from ordinary electric light circuits. (By the way, radio sets soon to be placed on the market by General Electric,

include a liquid type battery than can be recharged from the 110-volt lighting circuits.) Machines for beating gold to produce gold leaf have been invented; but since this is a very restricted trade requiring great skill on the part of the operators, inventors of the machine have decided to withhold it while the existing gold beaters are alive. Finally, Mr. Douglas calls attention to an anti-friction device for cylinders, developed during the war, which would make cylinders last much longer than they do now.

TO AVOID being wiped out by atomic bombs, must we change the whole design of our present cities into ribbon or one-street cities? How this might be done has been discussed by Edward Teller, Jacob Marshak and L. R. Klein, all atomic scientists connected with the former and present atomic work. A complete dispersal of population centers would be too costly and probably not feasible, according to these men. But they propose a series of ribbon cities following the terrain rather than a straight line. These ribbon cities would be spaced about 25 miles apart, with about 15,000 persons between intersections. It would not be too easy to hit such a ribbon with any kind of bomb; and even with an atomic bomb, much of the bomb's destructive power would be spent on the open regions between the linear cities. Life in such cities would be suburban rather than metropolitan or rural. Strategic buildings would have to be put underground, of course, the entire transportation system to supply such cities would have to be revised and greatest possible use would have to be made of all types of air transportation. Important railroad stations and intersection points of the network might have to go underground. A principal disadvantage in such a scheme would not be finances but the tremendous amount of labor and natural resources required to do the job within a relatively short period of time.

HYDRAULIC TURBINES have attained a high degree of perfection, developing efficiences of 93 per cent and more, which is extremely high for any prime mover. This high performance has been achieved largely through research in hydraulic laboratories, since the study of the flow of water is not an exact science. Because of the high efficiencies already attained, future gains will be attained in small steps. But due to the large size and great cost of hydroelectric developments, even small increases in efficiency have large monetary value. For that reason, testing of models has assumed, in recent years, an important function in the design of hydraulic turbines including not only increases of speed and reduction in size for reduced costs, but also the study of cavitation. Models of some of the world's most powerful hydraulic turbines are in the Baldwin hydraulic laboratory and a very interesting account of how these are tested together with many photographs of the models and test procedures, are given in the First Quarter, 1946 issue of *Baldwin,* Vol. 3, No. 1.

THE AMOUNT of reserve electric power capacity in the country that might be available for future war purposes, possibility of providing such reserve capacity as a necessary part of the nation's industrial preparedness, value of interconnection of power systems and system integration were among subjects discussed at a recent seminar on Electric Power and Industry Mobilization held at the Industrial College of the Armed Forces at Washington recently. Taking part in this seminar were many of the nation's top-ranking utility engineers and executives, from both private companies and large federal power organizations, as well as representatives of the chief of engineers and the Army. It was interesting to note that the Office of War Utilities, which functioned to co-ordinate the power systems of the country during the last war, was given considerable praise as the best way of handling war power problems with a minimum of controls. One suggestion was made that a permanent committee be formed to plan the nation's power controls for a future emergency, on the ground that it will be too late to develop such controls after the next war starts. The point was also raised that very large power stations in populated areas might be quite vulnerable to bombing attacks, as illustrated by what happened to some of the largest German Stations. The effects of the atom bombings of Hiroshima and Nagasaki were also discussed. At Hiroshima, according to one representative, everything was wiped out but at Nagasaki some sub-stations over a half a mile from the target were damaged but remained essentially intact.

DURING the war, American industry developed many miraculous things that we were told were going to revolutionize post-war living in America. Well, the cynics may carefully uncross their fingers for ten seconds while they listen to this one. Quick-frozen complete meals—400,000 of them in the last ten months —were prepared by the Maxson people for the Naval Air Transport Command, which served them on its planes. These ocean-flying blue plates carried an entree and two vegetables. There were 6 combination meals assembled on lacquered cardboard plates and frozen. Thawing and cooking takes only 15 minutes in a Maxson special oven with which the planes are equipped. They can, of course, be prepared in the ordinary oven at home but longer time is required in that case. They won't be along in the stores for some time but already we have seen a number of individual items prepared by the same method. Frozen french fried potatoes can be had in some localities. We have seen frozen pies, cakes and other things, although we have not yet had a chance to try them out. Another Maxson venture now proposed is frozen precooked sea foods prepared on the New England seacoast. Incidentally (or perhaps not so incidentally), all these frozen meals are heated and served on the composition plate in which they are packed; after dinner, you just toss out the plate. ***There are no dishes to wash!!!!!***

...SMALL TURBINES ARE HARD ON OIL

YOU have to consider unit-bearing pressure . . . maximum bearing temperature . . . lube system "tightness". . . times-per-hour oil is circulated . . . when judging how hard a turbine is on lubricating oil.

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For literature about turbine lubrication and turbine cleaning procedures, write to Shell Oil Company, Incorporated, 50 West 50th Street, New York 20, New York; or 100 Bush Street, San Francisco 6, California.

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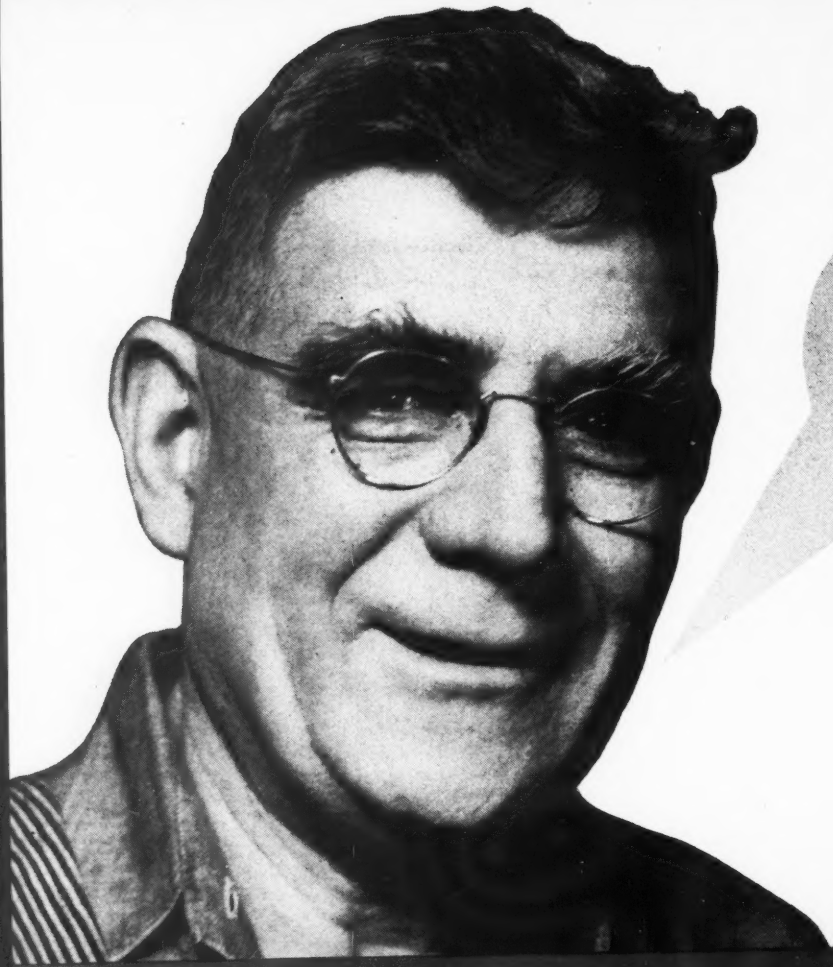

"GOOD
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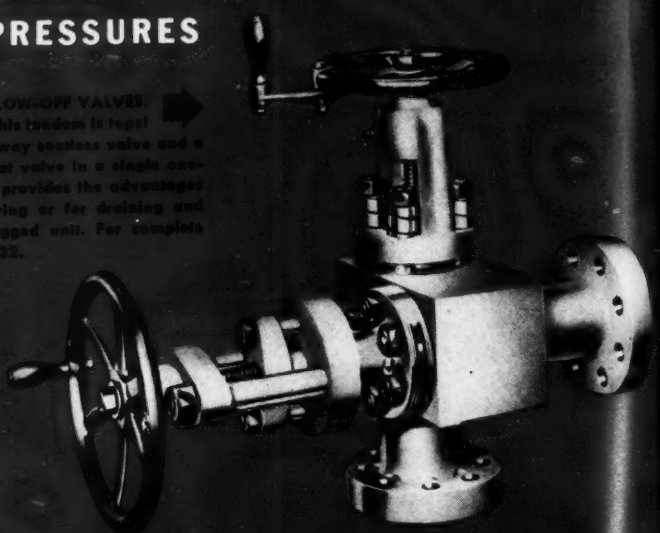
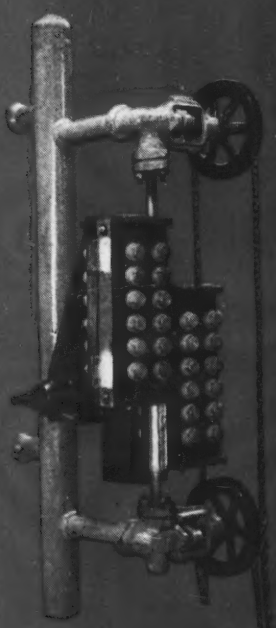
FOR HIGH PRESSURES

YARWAY UNIT TANDEM BLOW-OFF VALVES. For pressures to 2500 psi., this tandem is tops! Combining the famous Yarway seatless valve and a specially-designed hard-seat valve in a single one-piece forged steel body, it provides the advantages of both designs—for blowing or for draining and sealing—in a compact, rugged unit. For complete description see Bulletin B-432.





YARWAY HIGH PRESSURE WATER COLUMN with welded GAGE VALVES AND FLAT GLASS GAGE...for 1550 psi. Improved design gives extra strength and dependability. Flat glass gage inserts are mica protected and have spring-loaded cover-plate cap screws and pressure-sealed gaskets which prevent excessive strain on glass. Described in Bulletin WG-1810

YARNALL-WARING COMPANY, 114 Mermaid Ave., Phila. 18, Pa.

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we Need it... and Get it
YARWAY BOILER TRIM"

FOR ALL PRESSURES

YARWAY REMOTE LIQUID LEVEL INDICATOR. Here's an instrument that should be used with every boiler up to 1500 psi. It brings hard-to-see overhead water gage readings right down to eye level, on the instrument panel or other convenient place. Brilliantly-lighted red and green dial gives instant, accurate boiler water level readings. Always positive because it's operated by the boiler water itself.

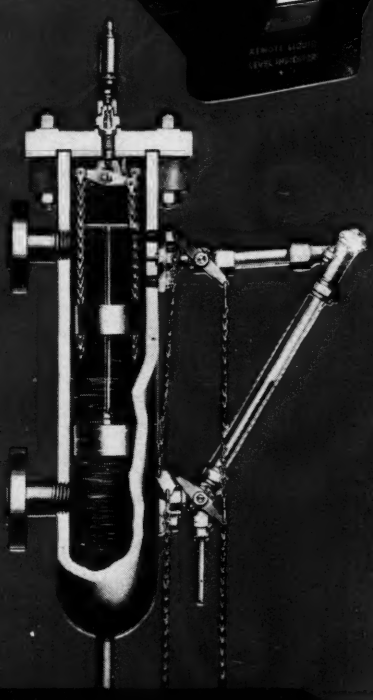
Indicating mechanism is never under pressure. *There are no stuffing boxes.* Action is instant, constant, and practically frictionless.

Moderate in cost . . . easy to install. Get complete description and operating details in Bulletin WG-1820.

FOR MEDIUM AND LOW PRESSURES

YARWAY HI-LO ALARM WATER COLUMN WITH SEISURE INCLINED GAGE. Alarm mechanism uses balanced solid weights and operates on the displacement principle to give instant, positive warning of dangerous changes from normal water level. For pressures to 600 psi. Described in Bulletin WG-1819.

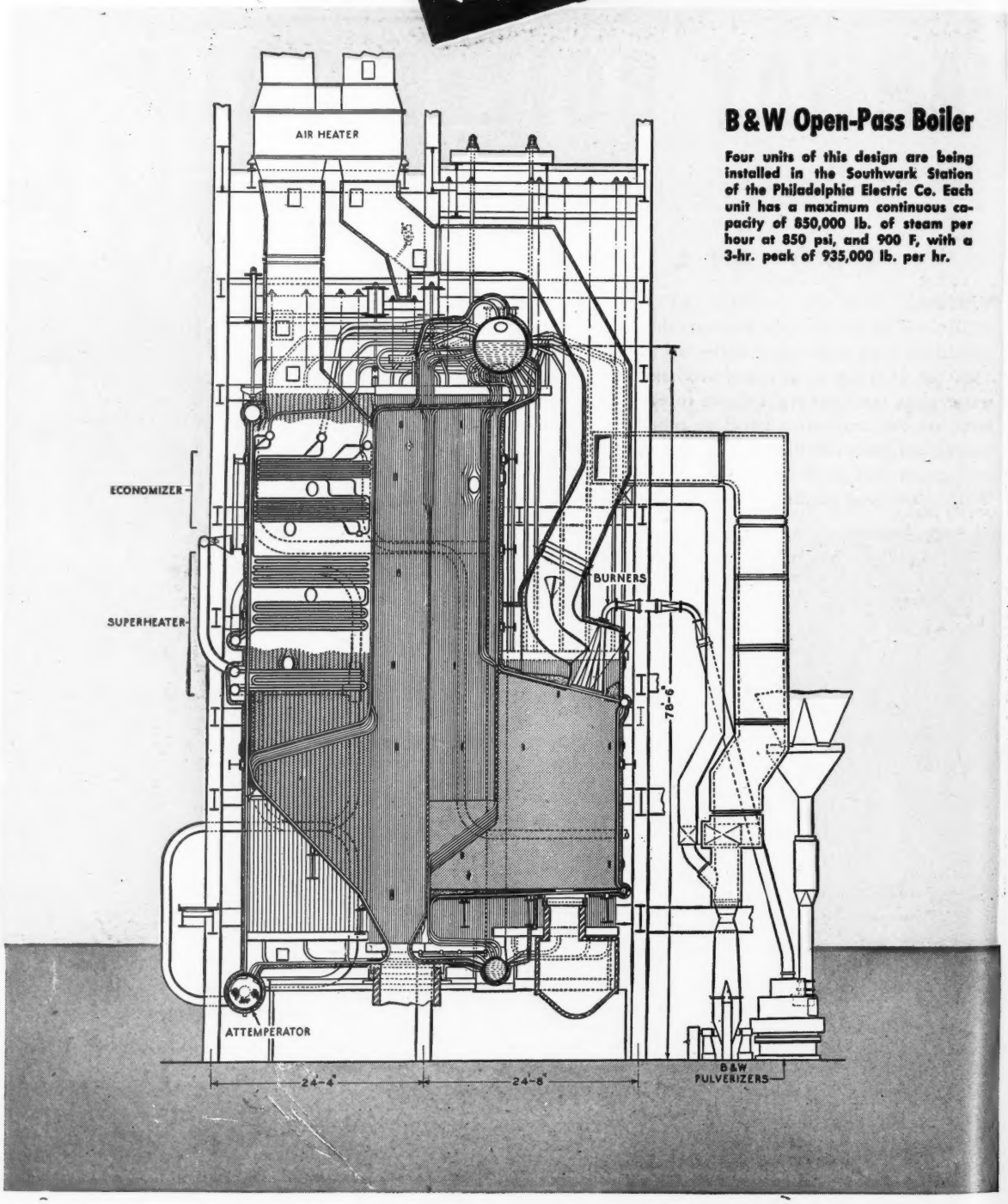
YARWAY SEATLESS TANDEM BLOW-OFF VALVES. These are the valves that are standard in over 12,000 boiler plants on pressures up to 600 psi. Balanced sliding plunger type with non-clogging, straight-through flow. No seats to score, wear, or leak. See Bulletin B-424 for pressures to 600 psi.; Bulletin B-432 for higher pressures.



STEAM PLANT EQUIPMENT

Steam for Southwark

B&W BOILERS



B&W Open-Pass Boiler

Four units of this design are being installed in the Southwark Station of the Philadelphia Electric Co. Each unit has a maximum continuous capacity of 850,000 lb. of steam per hour at 850 psi, and 900 F, with a 3-hr. peak of 935,000 lb. per hr.

Selected for *NEWEST*

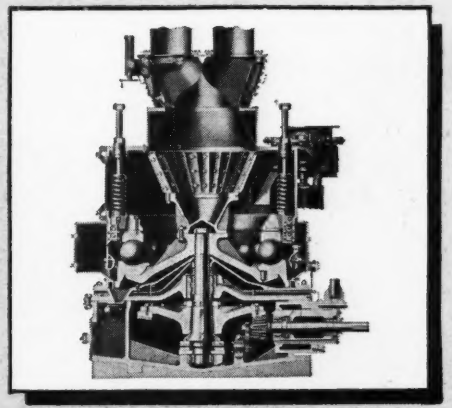
Philadelphia Electric Station

Reliability and simplicity were the foremost aims of the Philadelphia Electric Company in constructing and equipping its new Southwark Station, which will carry a large portion of the system's capacity. Comprehensive study of plant requirements and service conditions led to the selection of four B&W Open-Pass Boilers for this, the first station in the system to use only pulverized coal.

A factor, too, in the selection of B&W units for Southwark was Philadelphia Electric's satisfactory experience with similar B&W Boilers at its Chester Station.

On the basis of these two criteria—through study of plant needs, and past performance—B&W Boilers were indicated as the most attractive units from the standpoint of investment and operating costs consistent with estimated load conditions and capacity factor for the station's anticipated life.

Your requirements probably differ from those at Southwark. But whatever they are, B&W welcomes the kind of thorough analysis and close comparison that influenced the selection of B&W Boilers there. It's a good way to go about choosing the right boilers for low over-all power cost—and B&W is ready to help power engineers in *any* plant to achieve just that.



Four B&W Pulverizers supply fuel for each boiler. Practically full rated output can be obtained with coals having grindability as low as 55.

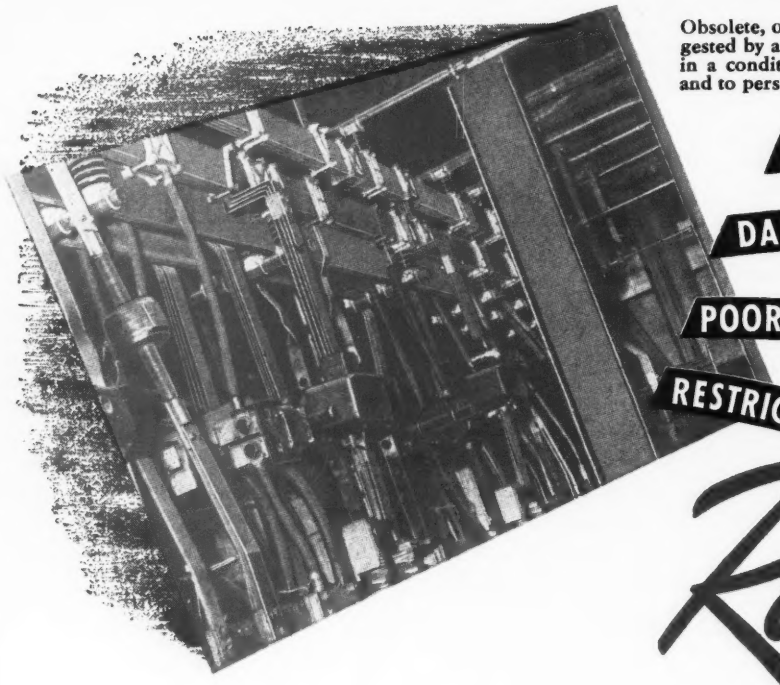
G-339 T

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.

GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: ALLIANCE AND BARBERTON, O.; AUGUSTA, GA.



Obsolete, open-type switchboard construction, congested by additions made from time to time, resulted in a condition dangerous to operating continuity and to personnel.

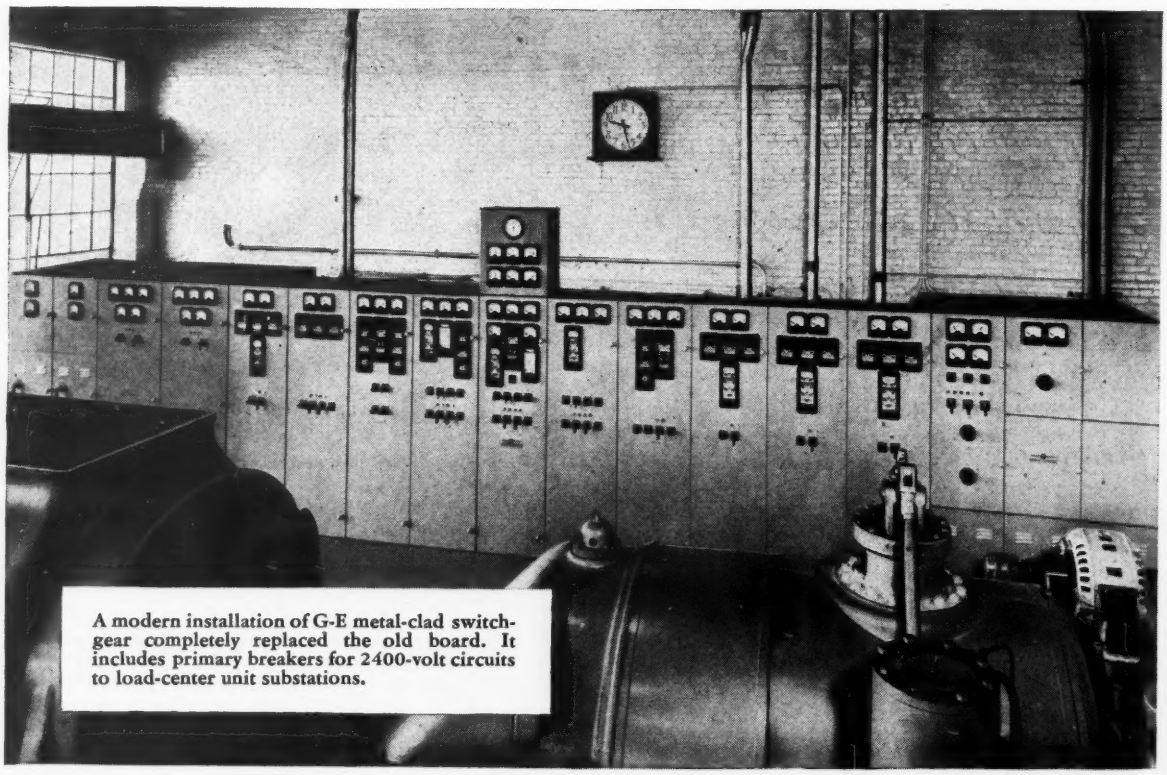
FREQUENT OUTAGES

DANGER TO PERSONNEL

POOR VOLTAGE CONDITIONS

RESTRICTIONS ON GROWTH

Removed



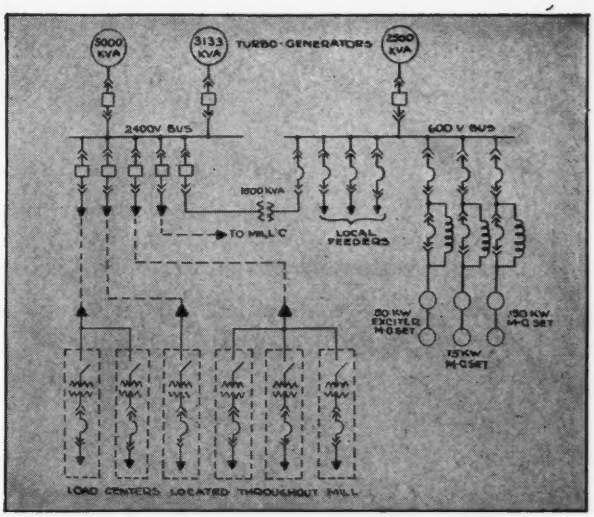
A modern installation of G-E metal-clad switchgear completely replaced the old board. It includes primary breakers for 2400-volt circuits to load-center unit substations.

GENERAL ELECTRIC

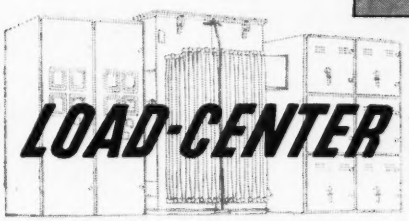
221-45-5900

Switchgear and Load-center Unit Substations are Shown in this One-line Diagram.

Originally, the 5000-kva generator was wound for 600 volts, and all but one circuit (to mill C) was powered from the 600-volt bus. The change to 2400-volt distribution brings short-circuit amperes to a value consistent with moderate-sized circuit breakers.



...BY G-E LOAD-CENTER UNIT SUBSTATIONS

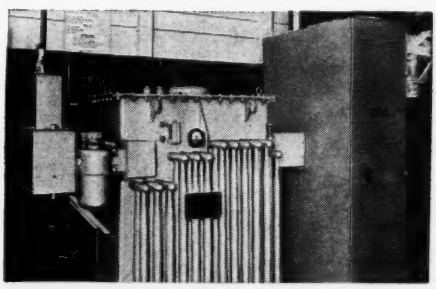


• An old, inadequate plant power system was an open invitation to trouble at this mill. Electrical outages were delaying production. Circuits and switchgear which had been added piecemeal added to the danger of inadequate interrupting capacity. In spite of large secondary feeders, the distribution of 10,000 kva at 600 volts had created unsatisfactory voltage conditions.

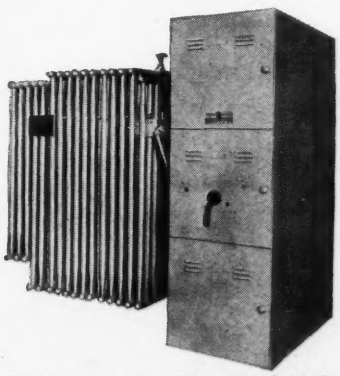
Analysis showed that further patchwork would be a costly practice. A new power distribution system, based on the use of G-E unit substations, was planned with the help of G-E engineers.

Now primary distribution is made at 2400 volts over cable that keeps voltage drop down, though it's modest in size. The powerhouse switchgear is all G-E metal-clad, equipped with magne-blast oil-less air circuit breakers. At load-center locations throughout the plant, six unit substations are installed, to step down from 2400 volts to 600. Individual circuits are fully protected by convenient metal-enclosed drawout air circuit breakers that are an integral part of the unit substation.

This new protection against outages and obsolescence is already justifying itself in power continuity and lowered costs. Why not determine, without obligation, if power-system replacement could do as much for you? Just call your local G-E representative. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*



Typical load-center unit substation, as installed at locations which permit short low-voltage feeders to points of power use.

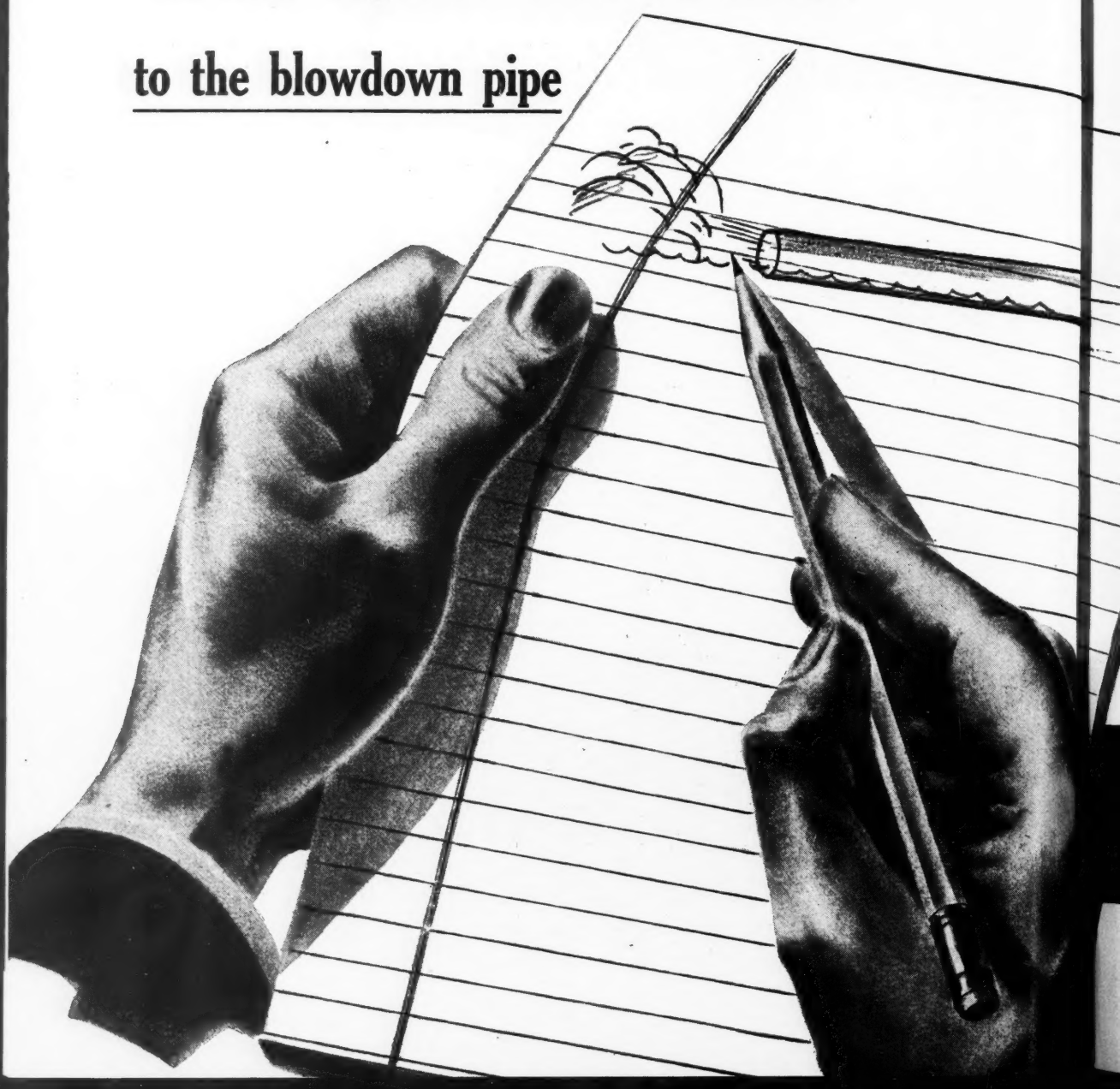


Another load-center unit installed in the mill, stepping 500-kva down from 2400 volts to 600. Draw-out air circuit breakers are co-ordinated with substation size to give full short-circuit protection without excess breaker size. Substation transformers use Pyranol non-inflammable insulating liquid.

LOAD-CENTER POWER DISTRIBUTION UNITS

Continued heavy sludge

The Hall engineer traced the trouble to the blowdown pipe



SHORTLY after the installation of a new boiler in an eastern foundry, heavy sludge deposits developed. Plant engineers and the insurance company inspector were greatly concerned about the condition.

Analysis of this sludge showed that its composition was normal, with nothing to indicate under-treatment with phosphate. Nevertheless, water conditions were thoroughly checked, and control of the boiler water was watched with additional care. Still the heavy sludge continued.

To the Hall engineer this indicated the need for examination of the boiler itself. On the basis of experience in other plants, he questioned the location of the internal continuous blowdown line. When the boiler was taken off for inspection and cleaning, this was checked.

As he had suspected, the blowdown pipe was so located that slight variations in water level meant the difference between blowing boiler water or steam.

The pipe was lowered. Arrangements were also made for heavy blowdown of the mud drum and water wall headers immediately after the load was taken off the boiler when it was shut down at weekends. Six months later when the boiler was again inspected internal conditions were found to be satisfactory.

"Trouble-shooting" such as this is all in the day's work for Hall engineers. Their experience is not limited to water conditioning—they have a thorough knowledge of boilers and boiler operation. Our records show that time and again the troubles encountered in plants which have Hall service are due to factors other than water.

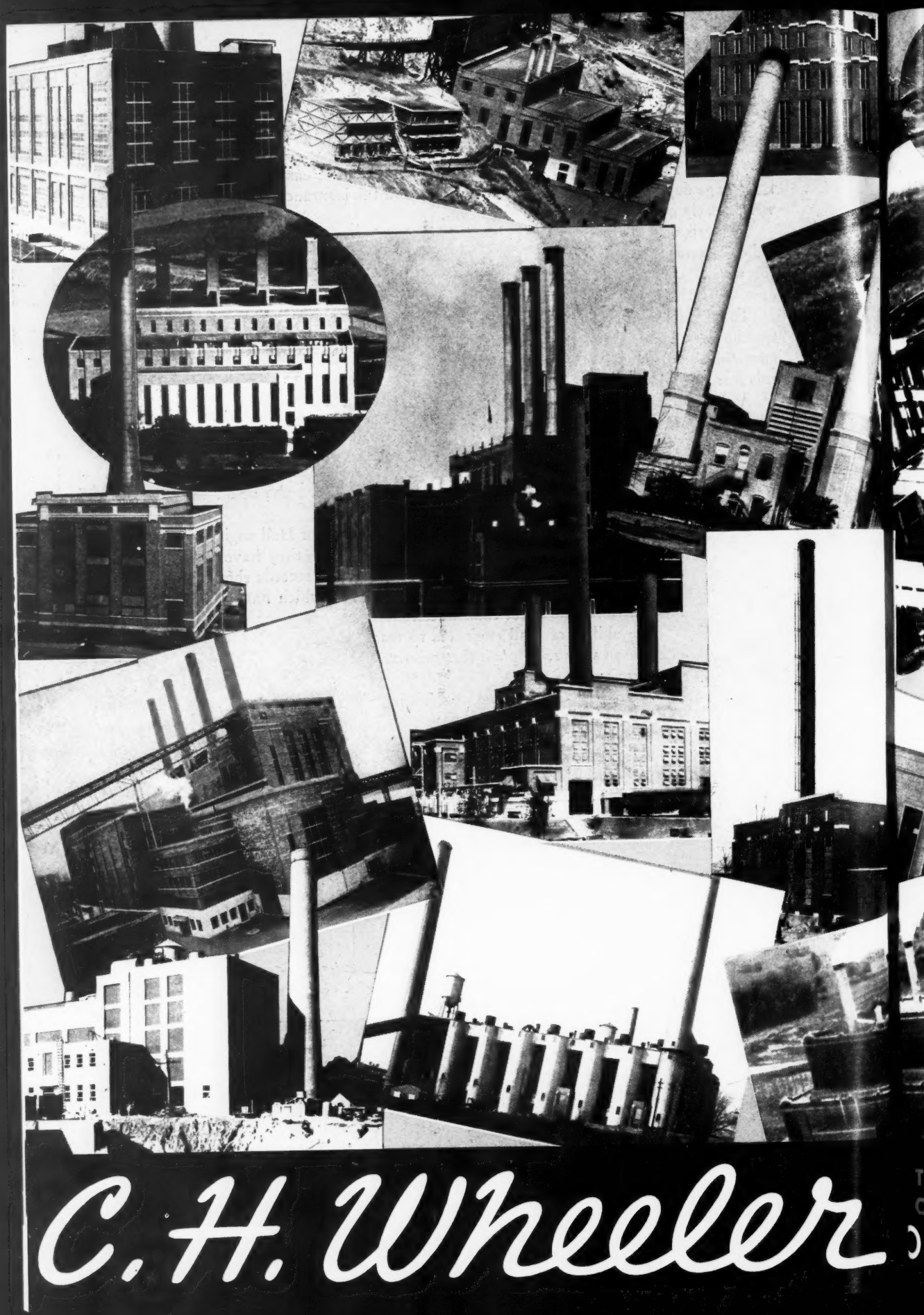
The ability of Hall engineers to trace and correct these troubles is one reason why *every plant that generates its own steam can profitably use Hall service.*

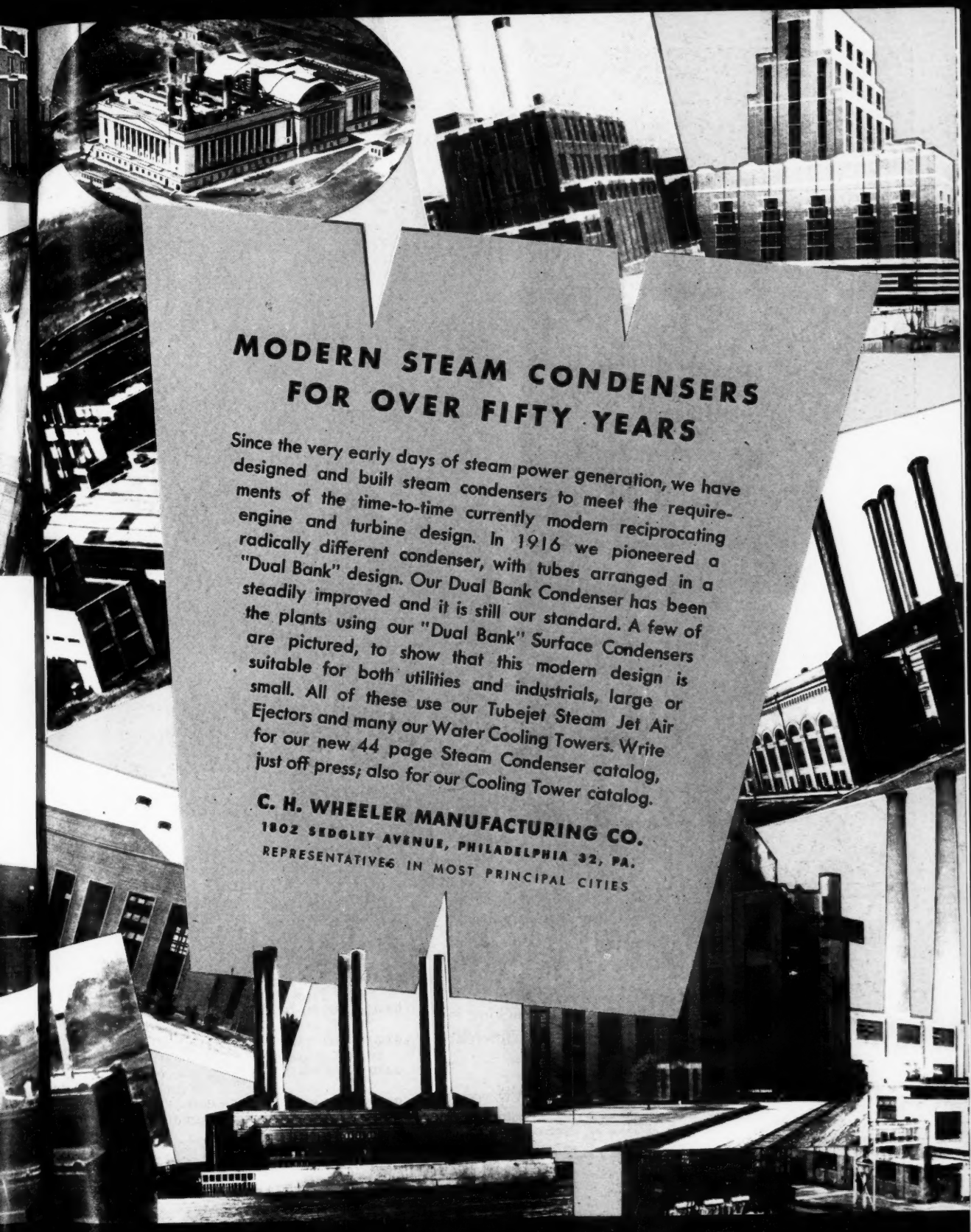
We will be glad to send you full information.

HALL LABORATORIES, INC., HAGAN BUILDING, PITTSBURGH 30, PA.
(A Subsidiary of Hagan Corporation)

HAGAN
HALL
BUROMIN
CALGON

HALL SYSTEM *of Boiler Water Conditioning*


C. H. Wheeler

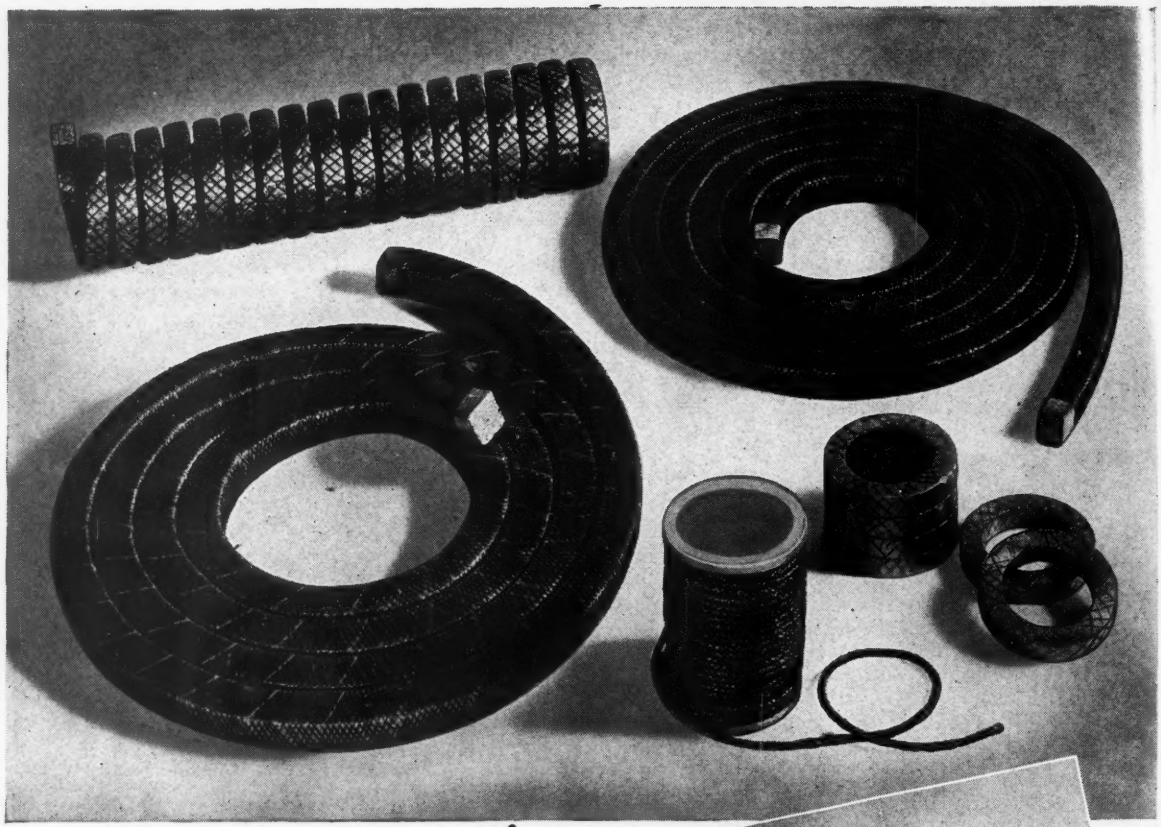


MODERN STEAM CONDENSERS FOR OVER FIFTY YEARS

Since the very early days of steam power generation, we have designed and built steam condensers to meet the requirements of the time-to-time currently modern reciprocating engine and turbine design. In 1916 we pioneered a radically different condenser, with tubes arranged in a "Dual Bank" design. Our Dual Bank Condenser has been steadily improved and it is still our standard. A few of the plants using our "Dual Bank" Surface Condensers are pictured, to show that this modern design is suitable for both utilities and industrials, large or small. All of these use our Tubejet Steam Jet Air Ejectors and many our Water Cooling Towers. Write for our new 44 page Steam Condenser catalog, just off press; also for our Cooling Tower catalog.

C. H. WHEELER MANUFACTURING CO.
1802 SEDGLEY AVENUE, PHILADELPHIA 32, PA.
REPRESENTATIVES IN MOST PRINCIPAL CITIES

TEAM CONDENSERS • AIR EJECTORS
OOLING TOWERS • HEAT EXCHANGERS
OF PHILADELPHIA



Easy to Apply

GARLOCK *Plastallic* packing is easy to apply. You just tamp the loose form into the stuffing box and draw up on the gland. Coil, spiral and ring forms are applied in the usual way. And when additional packing is needed, you merely back off the gland and add more *Plastallic.* In service it combines into one homogenous mass. A special feature of GARLOCK *Plastallic* coil packing is that it is out-of-square to fit either of two different packing spaces. Save time with *Plastallic!*

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada, Ltd., Montreal, Que.

GARLOCK 924 PLASTALLIC—for acids and strong chemical solutions.
GARLOCK 926 PLASTALLIC—for water, steam or air up to 550° F.
GARLOCK 927 PLASTALLIC—for gasoline, oils, ether, etc., up to 550° F.
GARLOCK 928 PLASTALLIC—for steam and hot oils over 550° F.
GARLOCK 929 PLASTALLIC—for water, steam and general services up to 550° F.
GARLOCK 930 PLASTALLIC—for gasoline, oils, gases, etc., at high or low temperatures.
GARLOCK 931 PLASTALLIC—for steam, water or air at high or low temperatures.

GARLOCK *Plastallic*

From the moment the Dearborn Engineer steps in your door, he is in your service.

He starts by making a thorough study of your boiler operating conditions.

He sends water samples to the Dearborn laboratories where accurate chemical analyses are made. Laboratory experts recommend the proper treatment and control methods for your complete protection.

. . . He makes sure that name means what it says

DEARBORN SERVICE TAKES TROUBLE OFF YOUR HANDS

If chemical feeding equipment is necessary, suitable means are recommended, making use of the versatile line of Dearborn mechanical equipment. He instructs your operators how to use the testing apparatus in connection with treatment adjustment and blowdown control. Thereafter, he makes periodic checks to insure maintenance of recommended boiler water conditions.

This service, indeed, means that your plant is set to deliver power!

Dearborn
TRADE MARK REGISTERED

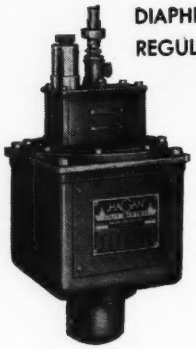
WATER TREATMENT AND ENGINEERING SERVICE

THE *LEADER* FOR OVER HALF A CENTURY

DEARBORN CHEMICAL COMPANY
Dept. F, 310 S. Michigan Ave., Chicago 4, Ill.

STEAM SEPARATOR

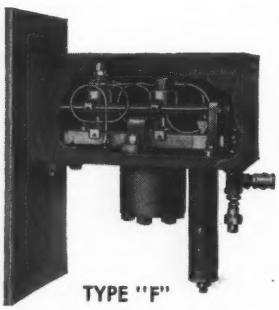
TYPE 2 SO REGULATOR



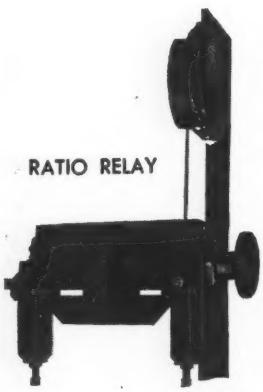
DIAPHRAGM REGULATOR

V PORT BUTTERFLY VALVE

If you need equipment for any of these applications



TYPE "F" MASTER SENDER

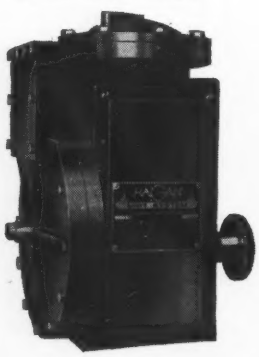


RATIO RELAY

get in touch with HAGAN CORPORATION

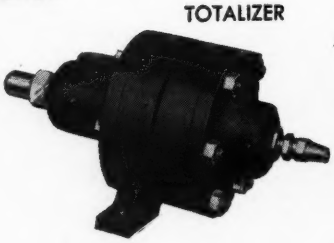
Hagan Building, Pittsburgh 30, Pa.

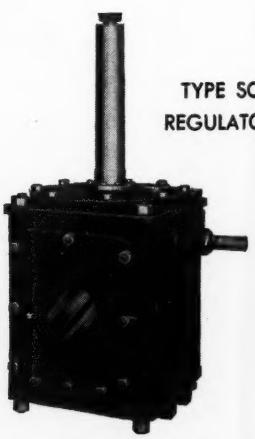
VARIABLE RATIO REGULATOR



RECEIVING REGULATOR

TYPE F TOTALIZER





TYPE SO REGULATOR

Combustion rate of boilers

Constant or graduated draft

Constant or graduated pressure (F.D.)

Feeder or stoker speeds

Flow of liquids

Control of multiple fuel firing

Fan speed control

Pump speed control

Hydraulic coupling control from speed or delivery of driven unit

Constant differential pressure (liquids or gases)

Constant differential draft (liquids or gases)

Graduated differentials (automatically or manually—liquids or gases)

Control of steam pressure

Control of pump discharge pressure

Control of pump discharge flow

Steam flow control

Steam pressure reduction

Steam temperature control (superheat)

Removal of oil and solids from exhaust steam

Removal of oil and moisture from compressed air

Steam desuperheating control

Separately fired superheaters

Flow of gases

Ratio control of gas flows

Ratio control of fuel and air (boilers)

Remote manual or automatic control

Flash tanks for recovery of steam from continuous blowdown systems

Program control for firing cycle

Oil burner control

Oil burner fuel-air ratio control

By-pass damper control for air preheater protection

Feed water heater pressure control

Feed water heater temperature control

Liquid level control

Control of multi-speed motor drives

Safety protection for gas or pulverized coal firing

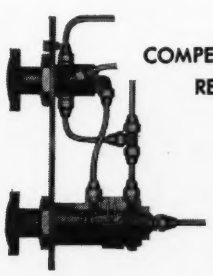
Steam jet refrigeration control

Removal of excess moisture and solids from saturated steam

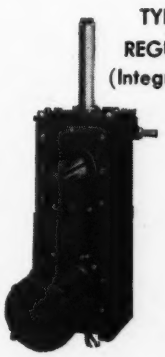
Force measurement and control

Measurement and control of Thrust and Torque

HAGAN
HALL
BUROMIN
CALGON



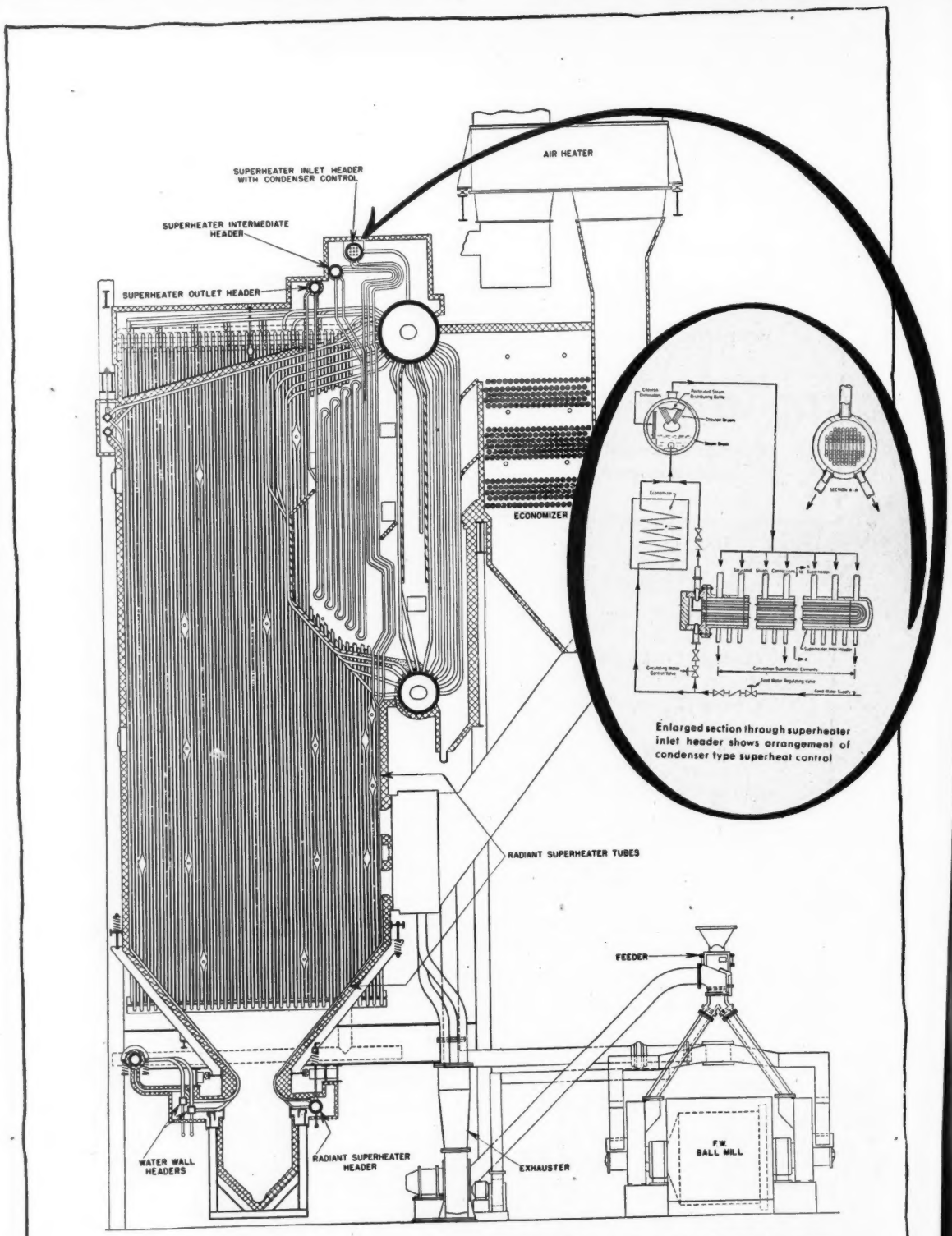
COMPENSATING RELAY



TYPE SO REGULATOR (Integral Pump)

HAGAN THRUSTORQ

MISSOURI AVENUE—



MISSOURI AVENUE STATION, ATLANTIC CITY ELECTRIC CO.

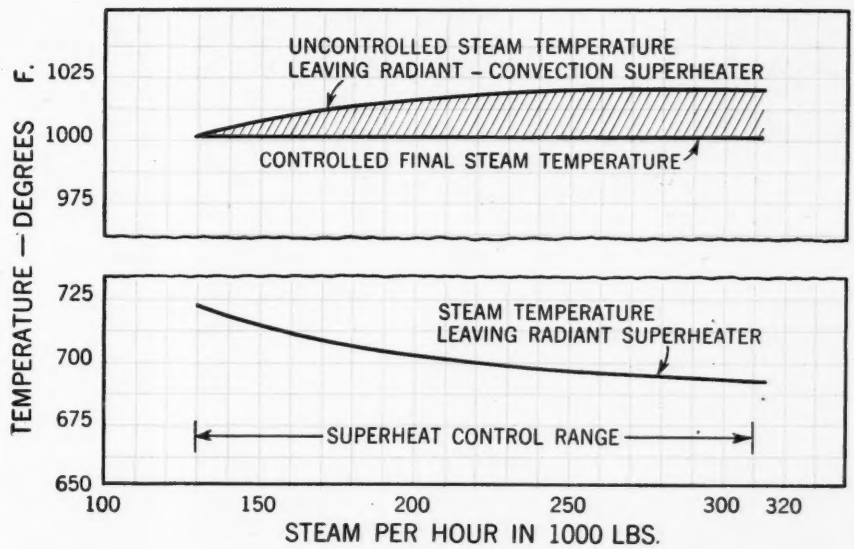
superheat control *maintains steady 1000°F* over wide load range

The first public utility steam generator designed for 1000 deg. F. final steam temperature, controlled over a wide load range, goes into service this fall at the Missouri Avenue plant of the Atlantic City Electric Company.

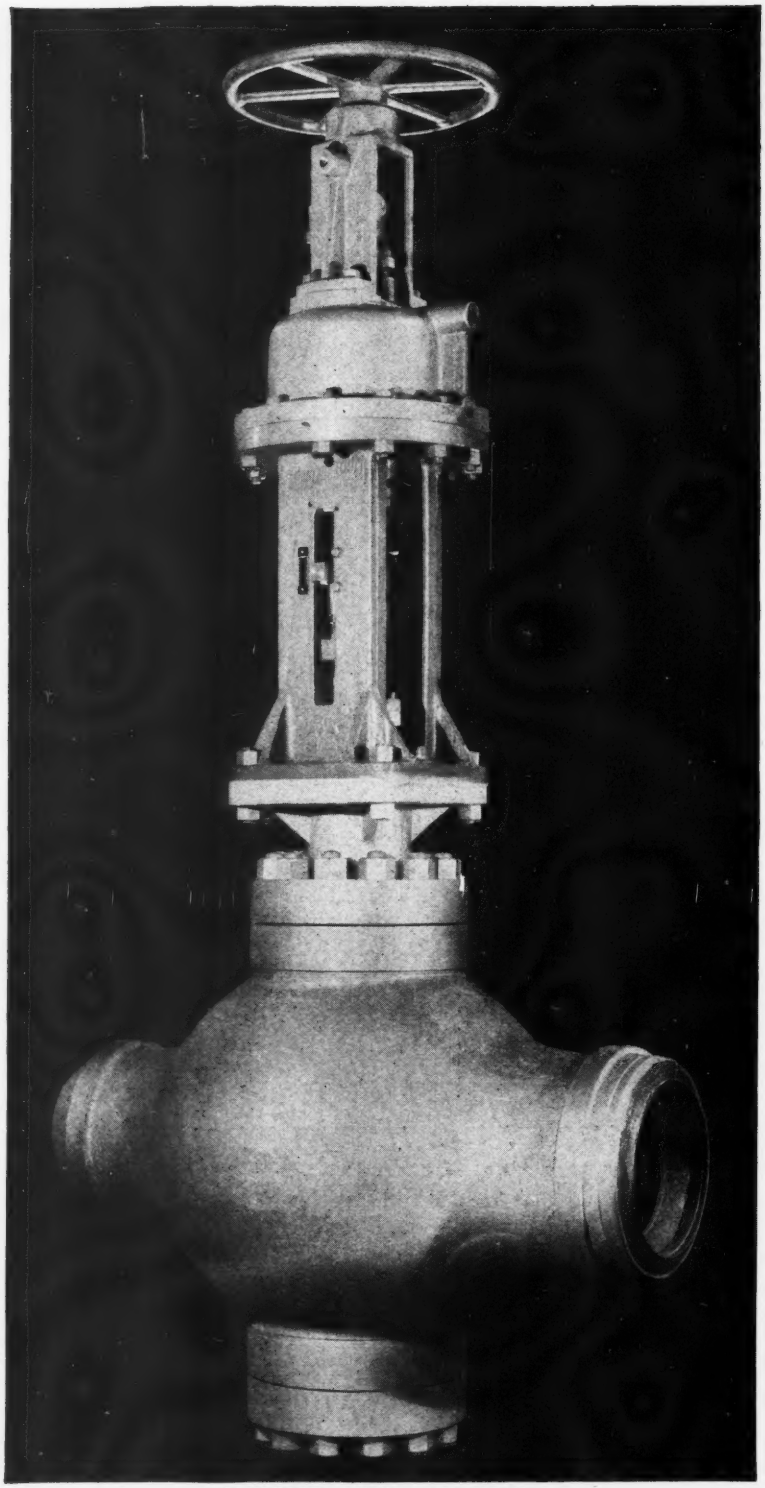
Complementary characteristics of radiant and convection superheater sections combine to yield an almost constant final steam temperature from 130,000 to 310,000 lb. per hour of steam. As the load varies over this range the uncontrolled steam temperature varies from 1000 deg. to 1020 deg. F. With the addition of condenser type control, superheat is maintained steadily at 1000 deg. over 58% of the load range.

Condenser type control introduces moisture at the superheater inlet header without adding water. Boiler water circulating through coils in the superheater inlet header condenses a portion of the entering steam, automatically regulating the amount of moisture entering the superheater. Positive and accurate control of final temperature is obtained, possible contamination of the steam is eliminated and excessive metal stresses due to temperature differences avoided.

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK 6, N. Y.



FOSTER WHEELER

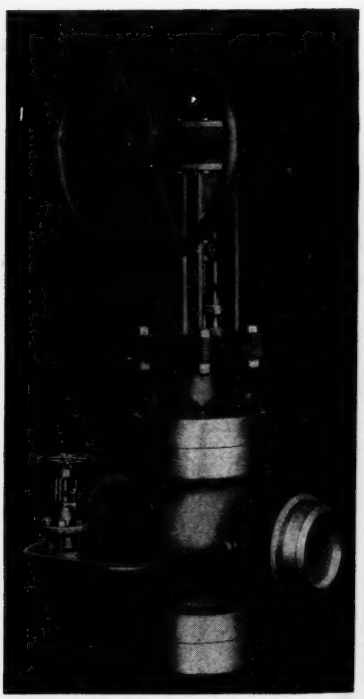


Republic 12 in. cylinder operated valve

REPUBLIC

GENERAL SPECIFICATIONS

- Built in all pressure standards—both flanged and welded ends.
- Streamlined flow through parts virtually eliminates erosion.
- Single seated valves—guaranteed drop tight.
- Double seated valves—guaranteed maximum leakage less than 1/2%.
- Steam valves have heat treated stainless steel trim with screwed in seats.
- Water valves have welded in seat rings with hard surface overlay—on small valves overlay is made directly on body.
- All valves are engineered to the job or application.



Republic 6 in. hand operated valve

REPUBLIC FLOW METERS CO.

VALVES REPUBLIC

Regulating — Pressure Reducing — Shutoff

CYLINDER OPERATED—double seated

Republic cylinder operated valves are of the gradual opening, high lift, double seated type. They are hydraulicly operated to assure smooth performance at any speed regardless of size, static pressure or pressure reduction. These valves are available in sizes from 3″ to 24″, with or without hand operating wheel. Due to compact design, a regulator may be mounted directly on the valve.

HAND OPERATED—large sizes

Republic hand operated valves, in sizes from 3″ to 8″, are built to 900 lb. and 1500 lb. pressure standards. They are of the single seated type, have a one piece valve stem, and seat rings that are Stellite surfaced and welded in place. The gear reduction head is built with ball or roller bearings and precision ground gears for minimum friction and back lash. These valves are recommended for flow control and shutoff applications.

HAND OPERATED—small sizes

Republic single seated hand operated valves are also available in 1″, 1½″ and 2″ sizes, built to 600 lb., 900 lb. and 1500 lb. pressure standards. These valves also have a one piece valve stem, and a Stellite surfaced seat integral with the valve body.

LEVER OPERATED—large sizes

Republic double seated lever operated valves are ideal for air actuation with long stroke cylinders. They are available in sizes from 3″ to 16″ for low pressure applications and in sizes up to 6″ for 1500 lb. applications. The lever mechanism, of sturdy construction capable of taking full strains of power cylinders, is adjustable with full cylinder stroke to change valve capacity.

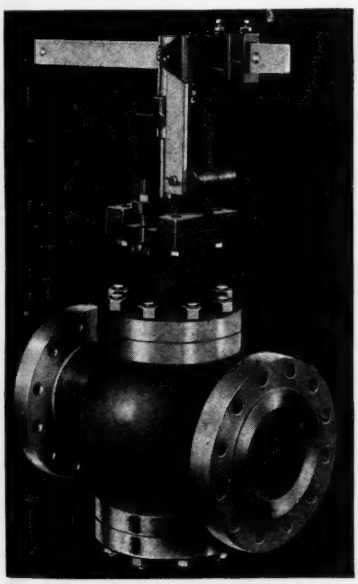
LEVER OPERATED—small sizes

Republic single seated lever operated valves are available in sizes up to 2″ and for pressures up to 1500 lb. standard. The valve seat is Stellite surfaced and integral with the valve body. The sturdy lever mechanism is adjustable for lift. Many of these valves are in operation on water lines with over 1000 lbs. pressure reduction.

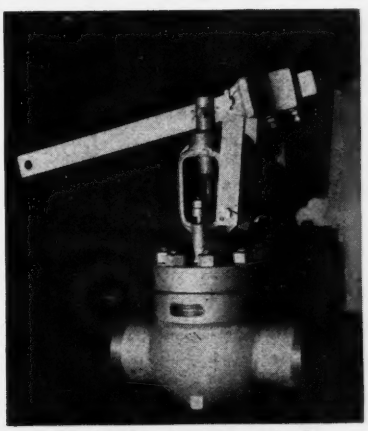
BUTTERFLY VALVES

Republic butterfly valves can be supplied in cast iron or steel for pressures up to 300 lbs. Vanes can be supplied of the angle seating or swing through types. The shaft can be mounted on ball or plain bearings as required. A valve operator may be mounted directly on valves of 6″ size and over.

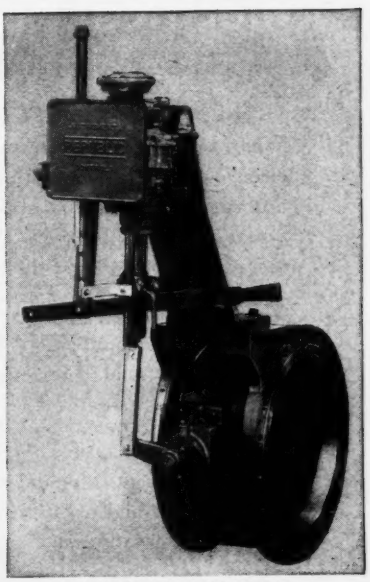
All Republic valves are engineered to the specific job on which they are to be used. Our engineers will be glad to consult with you on any of your valve problems. Write, asking to have one of our engineers call.



Republic 6 in. lever operated valve

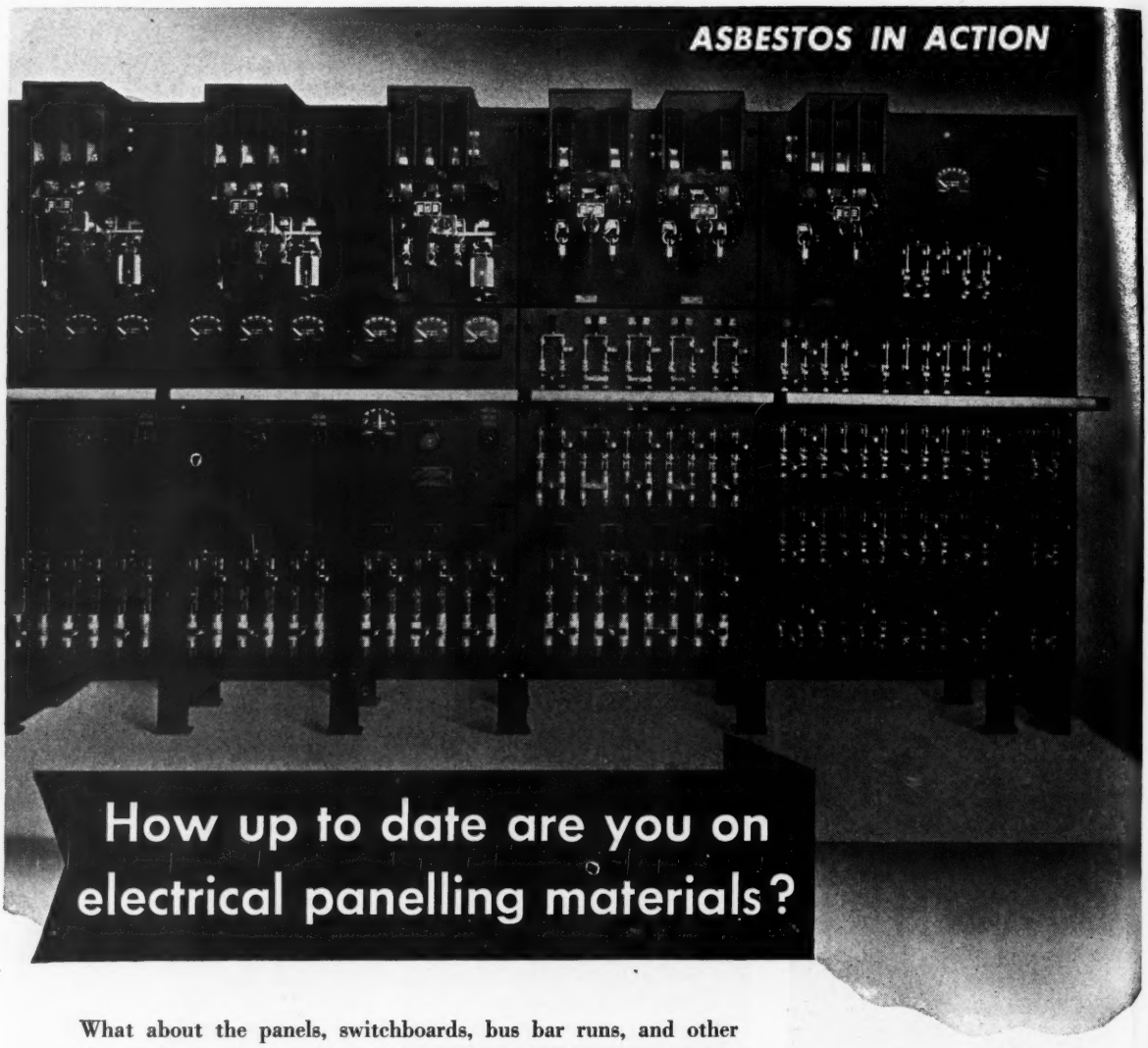


Republic 2 in. lever operated valve



Butterfly valve with operator

2240 Diversey Pkwy., Chicago 47, Illinois



How up to date are you on electrical panelling materials?

What about the panels, switchboards, bus bar runs, and other electrical apparatus mountings in your plant? Are they proof against absorption of moisture and oil? Do they stand up under high voltage surges, vibrations, and temperature changes, retain a business-like appearance without costly maintenance?

You can answer "yes" to all those questions if your electrical apparatus is mounted on K&M Ebonized Asbestos, the *modern* panelling material. Fabricators who work it and plants that use it say Ebonized Asbestos is ideal for the purpose.

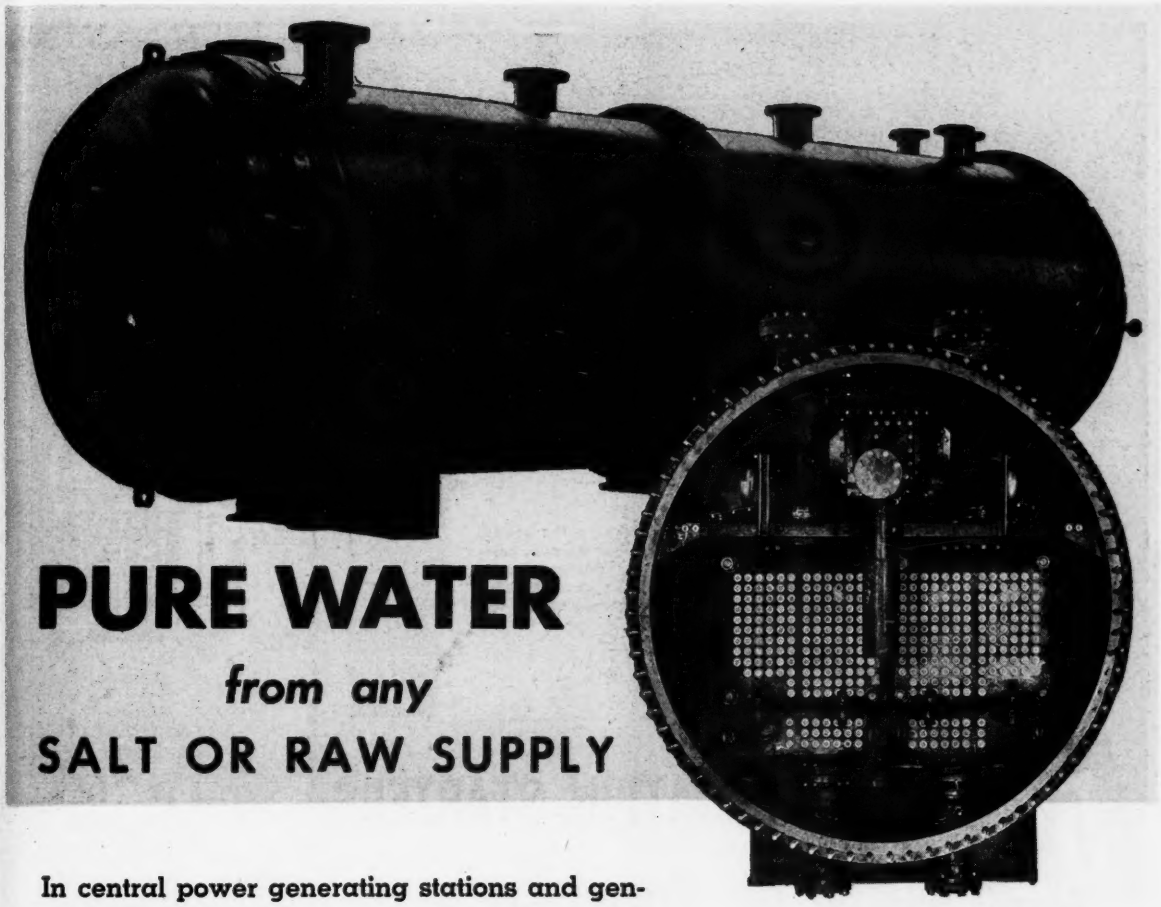
Made of tough asbestos fibres, cement and an insulating compound, K&M Ebonized is moulded into strong monolithic sheets with exceptionally high dielectric strength. It gives extra-long service, in fact it grows tougher with age. Meets the requirements of Underwriters' Laboratories, Inc., when built into an assembled unit. Write us for full technical data on this superior mounting material.

Photograph courtesy I.T.E. Circuit Breaker Co.

Nature made Asbestos...

Keasbey & Mattison has been making it serve mankind since 1873

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA



PURE WATER

from any

SALT OR RAW SUPPLY

In central power generating stations and general industrial plants . . . on naval and commercial vessels . . . in refineries and chemical process plants . . . wherever pure water is required for boiler feed make-up, process work, or general services . . . G-R Evaporators have established records for dependable, economical operation. These units do not require hand-scaling, and can be maintained by unskilled labor. Varying raw water conditions do not affect the product under wide limits. The distillate produced meets the exacting purity requirements of present day practice.

Look into this G-R BENTUBE EVAPORATOR

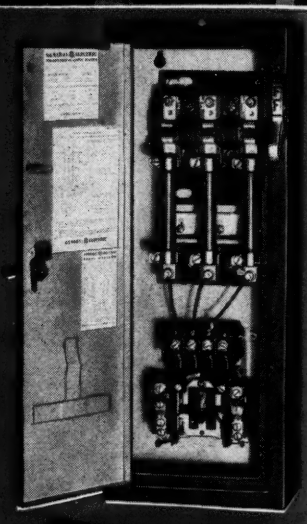
Note the rugged construction, unusually large clearances, and widely spaced tubes. The heating surface of this unit consists of patented scale-shedding Bentube elements. Temperature variations change the curvature of the tubes, thereby shedding the scale. G-R Bentube Evaporators can be furnished for large or small capacities, and in single or multiple effects for any requirements.

THE GRISCOM-RUSSELL CO., 285 Madison Ave., New York 17, N. Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

Sacking the seeds, one of the many processes controlled by G-E combination starters at the Rohnert plant



59 G-E COMBINATION STARTERS Control the Processing of 1/4 of the World's Vegetable Seeds

COMBINATION STARTERS SAVE TIME, SPACE, AND MONEY

Every process from eliminating dirt and debris to sorting the seed to size is controlled by G-E combination starters at the Waldo Rohnert Co., world's largest producers of garden vegetable seed.

In their four-story plant, completed in 1944, and said to be the most modern of its kind in the country, ¼ of the world's garden vegetable seed is processed—that's far more than a million pounds of clean seed a year. All electrical, it boasts 59 General Electric CR7008 combination starters and supplementary control which regulate the five separate seed mills of their complicated seed mill system.

According to Fred Rohnert, son of the founder, *"Our G-E controls and equipment have proved extremely satisfactory. They've given us no trouble since their installation."*

And here's why these starters have proved so satisfactory—

COMBINATION STARTERS SAVE TIME—

In addition to the time saved in ordering, outstanding savings in installation time are made with these starters. Users report a 50 per-cent reduction in mounting time, a 40 per-cent reduction in wiring time, as compared with the installation of two separate devices. You connect to only 9 terminals instead of 15.

SPACE—

Valuable wall space is saved because combination starters can be installed in small, unused places either near to or remote from the operator.

AND MONEY—

While the list price is slightly higher than for two separate devices, the difference is more than made up by savings in wire, fittings, and time.

WHAT IS YOUR APPLICATION?

Combination starters come in a variety of enclosures to meet any operating condition in your plant. If you'd like more information, ask our nearest office for Bulletin GEA-2715A. And remember, our engineers will be glad to help you with your application. ***Apparatus Dept., General Electric Co., Schenectady 5, N. Y.***

GENERAL ELECTRIC

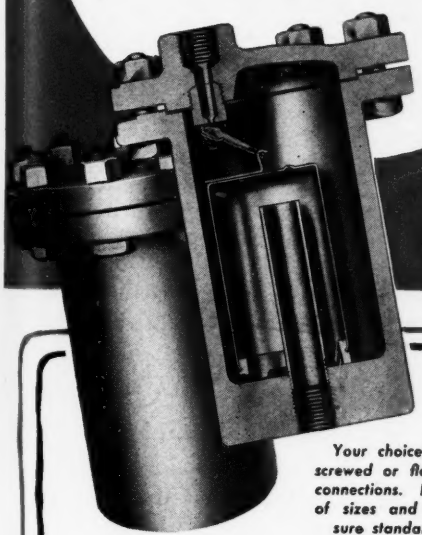
976-201-8910

Photo shows trap draining boiler superheater header.

One of a series of advertisements, each discussing trapping practice on a different class of equipment.

HOW TO TRAP HIGH PRESSURE STEAM LINES

—for dependable, trouble-free service



Your choice of screwed or flanged connections. Range of sizes and pressure standards.

QUALITY CONSTRUCTION!

- **VALVE AND SEAT.** Special chrome steel (stainless), hardened, ground, and lapped in matched sets.
- **INTERNAL TRIM.** All-stainless 18-8. Includes inverted bucket, valve lever, and guide pins.
- **CAP AND BODY.** Die forging (SAE 1030), 70,000 lbs. tensile strength.
- **BOLTS.** Supertemp, 149,000 lbs. tensile strength.
- **NUTS.** Hex, semi-finish (SAE 1030).

ARMSTRONG FORGED STEEL STEAM TRAPS

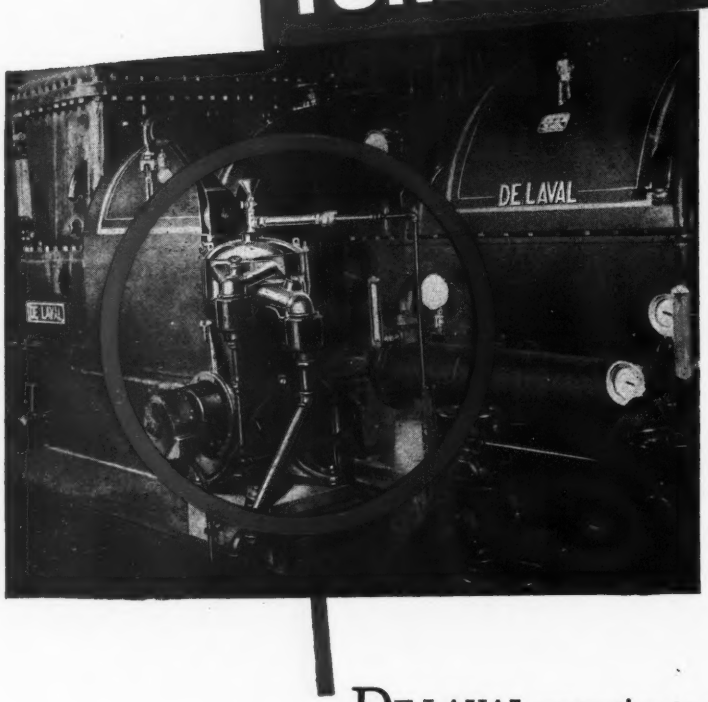
IT'S EASY to get dependable, trouble-free, high pressure trap installations when you use Armstrong Forged Steel Traps and follow Armstrong recommendations. On page 19 of the Armstrong Steam Trap Book (ask for a copy) you will find complete information on figuring condensate loads . . . selecting proper size of trap . . . arranging piping for greatest convenience and best drainage.

Here are some tips. Calculate the "warming up" load as well as the normal radiation loss load. Consider the possibility of sudden loads due to "carry-over" or opening of closed valves. Use a trap sizing safety factor of 2 or 3 to 1, except when pressure loss in long connecting lines may make a higher factor advisable. If possible, install traps close to and below source of condensate. If check valves are needed, consider the use of Armstrong internal type check valves. ARMSTRONG MACHINE WORKS, 810 Maple St., Three Rivers, Mich.

ARMSTRONG *Quality Built* **STEAM TRAPS**

Over a Million in Use...For Power...Process...Heating

TURBINE PROTECTION



THAT DOES NOT STOP HALFWAY

DE LAVAL protection to a turbine goes the whole distance. It removes ***both*** contaminants—***dirt*** and ***water***—and keeps the lubricating oil at its best at all times.

It is not sufficient to remove dirt only from turbine oil. While dirt obviously soon ruins oil as a lubricant, as often as not the chief offender in that respect is ***water***. For water, either as condensate or as solid "slugs" leads directly to the formation of sludge. It is also apt to emulsify the oil and cause serious difficulty in that way.

De Laval Oil Purifiers, wholly mechanical in action, remove dirt and continuously discharge the water, effecting separation by centrifugal force. The machines maintain full efficiency of purification at all times, right to the moment when the bowl is full and must be cleaned.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 19
THE DE LAVAL COMPANY, Limited
MONTREAL PETERBOROUGH WINNIPEG VANCOUVER

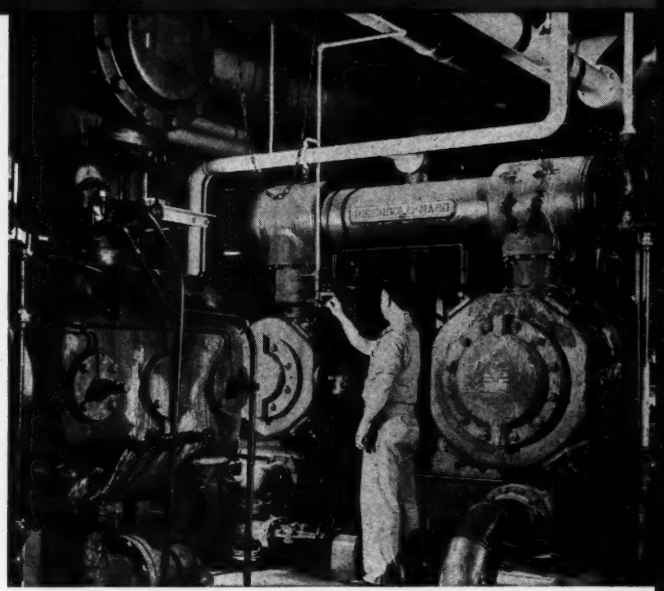
DE LAVAL OIL PURIFIERS

FOR MORE DEPENDABLE POWER PRODUCTION

DOWELL

A PAGE FROM THE DIARY OF THE DOW CHEMICAL COMPANY

cooling jacket efficiency restored



Chemical cleaning removes scale —increases power!

Cooling jackets clogged with scale and sludge decrease engine efficiency, retard power output. To remove these *insulating deposits*, modern plant engineers call on Dowell—because Dowell's *chemical* cleaning method is thorough, economical and rapid. It's the modern way to restore designed operating efficiency—to remove scale—to increase power!

Dowell specialists offer a complete service . . . including careful selection of the correct solvent for your job—and they bring with them all chemical mixing and pumping equipment required.

For more information on the *chemical* cleaning of compressors, gas engines, diesels, air conditioners—for boilers, condensers, filter beds—for water lines, for many types of *heat-exchange equipment*—and for increasing water well output—call the nearest Dowell office. Ask for free color booklet—"More Power to America's Industry!"

FREE SHOWING! Now available—a new 18-minute sound slide film illustrating the possibilities of Dowell Chemical Scale Removal Service. A Dowell representative will gladly arrange a special showing at your plant, office or organization meeting. Call or write Dowell today.

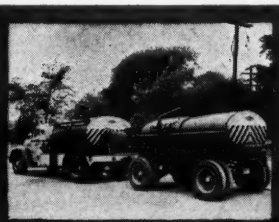
DOWELL INCORPORATED · TULSA 3, OKLAHOMA

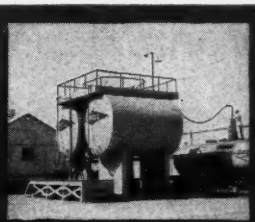
Subsidiary of The Dow Chemical Company

New York • Philadelphia • Baltimore • Buffalo • Cincinnati • Cleveland • Chicago
Detroit • St. Louis • Houston • Kansas City • Wichita • Pittsburgh • Mt. Pleasant, Michigan • Salem, Illinois

Long Beach, Casper: Dowell Associate—International Cementers, Inc.

SPECIALISTS IN CHEMICAL CLEANING SERVICE

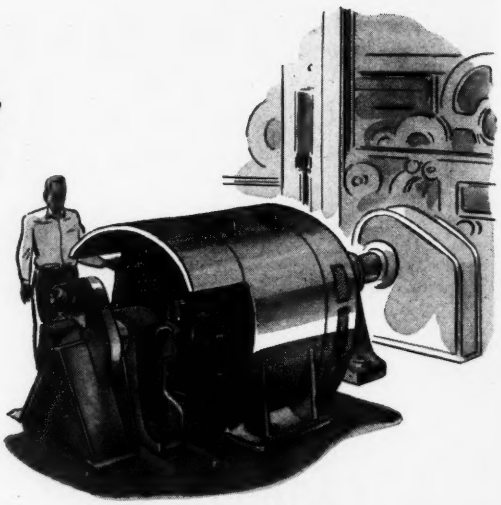




DOWELL

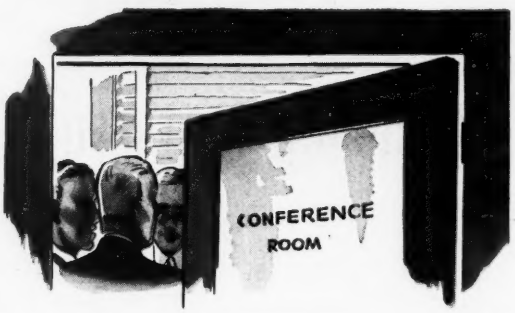
FOR INDUSTRIAL CHEMICAL SERVICE

"What! Stop a 30" Calender Roll in Less than 14" of Roll Travel!"



"Right! And besides that emergency stop, give us 10 to 1 speed range on the motor and hold speed *close*. The torque characteristic of our calender requires that the motor have high overload capacity at low speeds without overheating. And because of operating conditions, we want sparkless commutation too!"

B-b-u-t-t... "No buts" said Mr. Rubber Mill Man, "that's *exactly* what we need. You see, we're experimenting with new materials on our rolls, and since we can't *pre*-determine best roll speeds for them, we must have a drive that'll give us complete *range* of speeds, and at the same time, complete *protection* for our workers".



"In A Nutshell, you and the control engineers must design a calender drive system that'll give us *higher* and *lower* calender speeds, *closer* speed regulation and *sudden* emergency stopping —*" all three!"* Well, we set up meetings between the control and motor designers to plan a *coordinated* design that would meet the needs.

An Automatic Speed Control incorporating both our m-g set and "Regulex" exciter was designed to hold selected speed within close limits. And, after a careful analysis of required load characteristics, we designed a 400 hp d-c motor of low inertia for quick stopping . . . and which also provided speed range from 25 to 250 rpm.

Remember That 14" Stop? After the system went in, we stopped the rolls first at 18" . . . easy. Then at 14" . . . at 12" . . . at 9"! And we probably would have stopped 'em even shorter but for possible danger of too sudden stops to the calender gear system. And commutation? After 6 months, the operators say it's perfect. A 2048

Moral: Every time Allis-Chalmers discovers new ways of solving *special* motor problems, like this one, it also learns how to build better *standard* motors for you! Watch for these new and better motors from A-C. ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

Wait 'til you see the NEW
ALLIS-CHALMERS MOTORS!

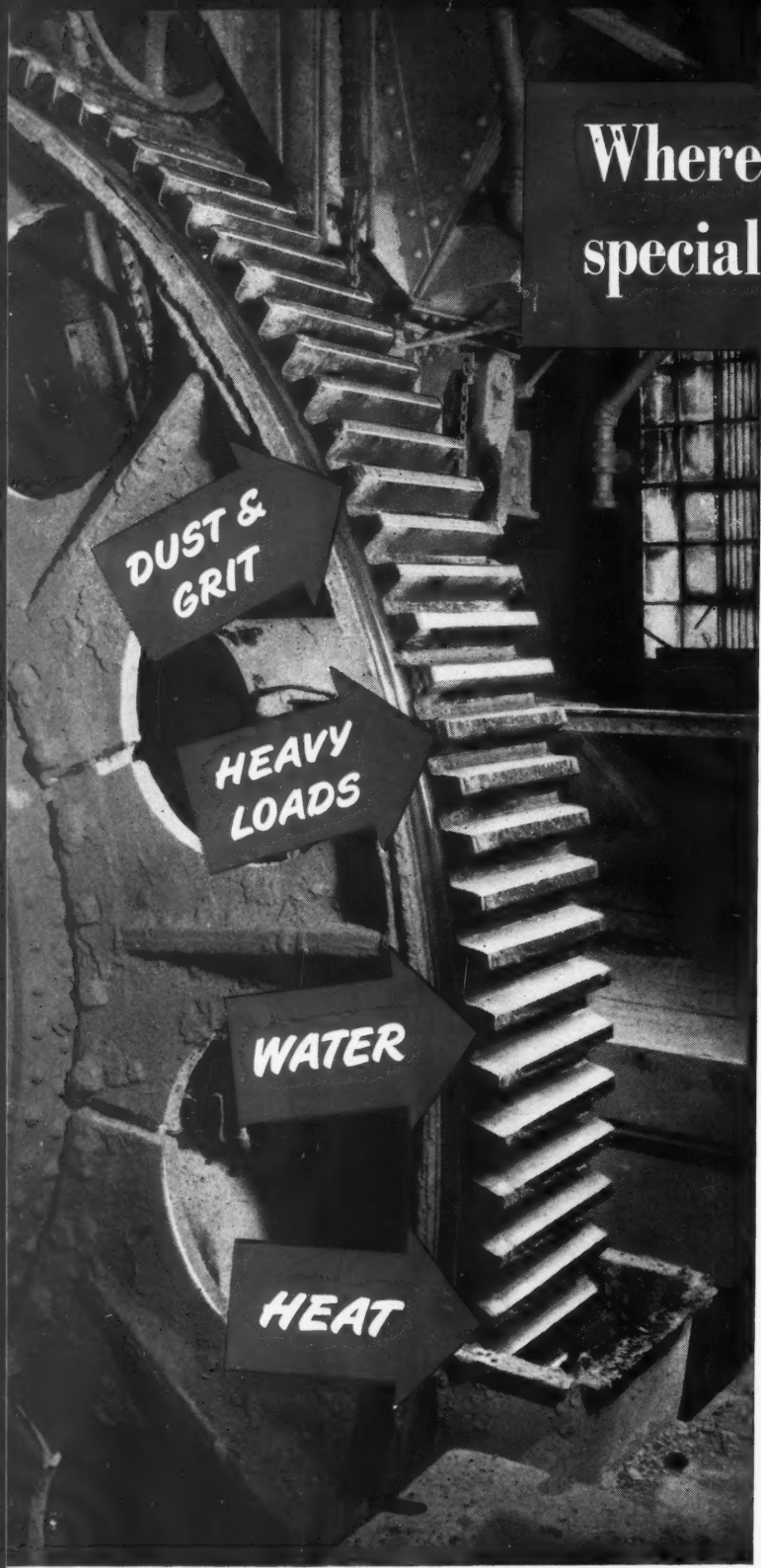
Learn how low low-cost Diesel power can be

YOU CHOSE DIESELS for power because of their inherent low cost operation. You probably made this choice long before modern, heavy duty Diesel oil was available. Even then, in spite of periodic cleaning and overhauling that was needed, power costs were low. Now, with Nonpareil HD Diesel Oil, you have an opportunity to further lower costs. You can lengthen the time between inspections, and the amount of cleaning and replacements needed will be less even with the longer periods of operation. It is not unusual for operators to find half the normal cylinder wear after a year's operation on Nonpareil HD. Low wear, unusual cleanliness, few shutdowns and repairs with Nonpareil HD will give you a new measure of how low low-cost Diesel power can be. Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

NONPAREIL HD
DIESEL OIL

STANDARD OIL COMPANY (INDIANA)

STANDARD SERVICE



Where large gears need special protection use . . .

CALUMET
Viscous Lubricants

DUST AND GRIT, heavy loads, excessive heat or wate are some of the adverse conditions under which o dinary gear shields cannot give adequate protectio Calumet Viscous Lubricants are not the old type gear shield, usually made from residual products petroleum. They are true greases, manufactured fro selected soaps and oils, plus additives, to secure t quality most needed in a modern gear lubricant.

Calumet Viscous Lubricants offer these advantage

1. Give long lasting protection. An additive Calumet Viscous Lubricants gives them improve wetting ability—that is, the ability to adhere closely metal. This not only provides a long lasting film, u der ordinary operation, but a film that resists he and water.

2. Save time in application. Because all grade can be applied without heating, and all except th heaviest grades can be sprayed, Calumet Viscou Lubricants cut application time to the minimum.

3. Reduce throw-off. Because spraying gives smooth, even coating of lubricant, it eliminates apply ing excessive amounts which may drop off before th lubricant is worked into the gears. Good wetting abil ity prevents throw-off during operation.

Let this wear-reducing, time-saving lubricant pro tect open gears on all types of equipment. A Standar Oil Lubrication Engineer will survey your plant an help determine the grades you need and the mos economical method of application.

Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA)

STANDARD SERVICE

How to get a "SWEET" CONTROL JOB

There's More to Boiler Controls Than Regulators

If you want a sweet running control for your boiler plant—look to more than bare regulators when you write your specifications. Here are some additional points to consider:

1 *Insist on controllable equipment*

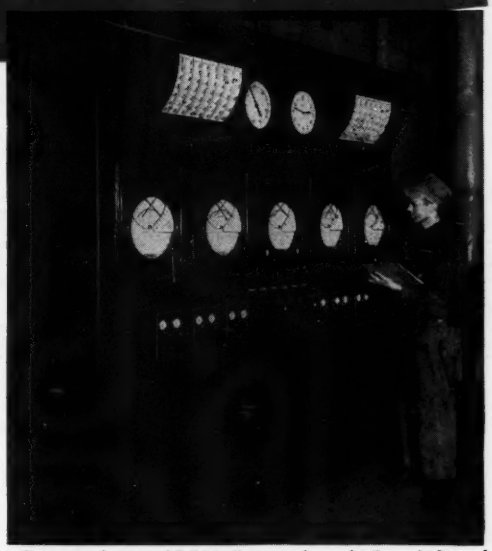
Fans, dampers, pulverizers, stokers, burners, and other equipment must be adaptable to automatic control before any system can give truly satisfactory results.

2 *Control from all important variables*

Multiple element control systems which respond to all of the important variables, insure against costly disturbances in plant operation. They increase safety, decrease auxiliary power required, and reduce the storage capacity needed in heaters and boiler drums.

3 *Profit from the experience of others*

Steam plants similar to yours already are being operated at optimum performance by Bailey Boiler Control. Your dividends, from our experience in making thousands of boiler control installations, take the form of refinements in control application which insure trouble free operation. Over 8,000 boiler units have been equipped with Bailey Controls during the past ten years. These units range from 3,000 to 1,000,000 pounds per hour capacity and operate at pressures from 75 to 2,500 psi. They are fired by pulverized coal, stokers, oil, gas, mixed fuels and waste fuels.



Control of two 65,000 lb. per hour boilers is based on the accurate measurements of these Bailey Meters at The White Motor Co., Cleveland, Ohio. Day to day evaporation runs consistently above the guarantee.

4 *Operate control from accurate measurements*

A control system is no better than the measurements to which it responds. Bailey Controls are based on accurate measurements made by Bailey Meters.

5 *Consult Qualified Application Engineers*

Bailey Engineers are qualified by training and experience to consult with you on both the theoretical and practical aspects of your boiler control problems. These specialists are conveniently located in over 30 industrial areas throughout the United States and Canada.

Details for Your Problems

If you want details write for a copy of Bulletin 15-D or ask a Bailey Engineer to call.

BAILEY METER COMPANY

1040 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Steam Plants

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

A-98-1

HERE are three stoker designs – each developed to meet a different combination of requirements – which have demonstrated through actual survey, their complete suitability for 90% of all installations covered by C-E contracts of recent years.

These three simplify the problem of stoker selection to one of merely determining which type is the answer to your conditions of steam load, boiler design, and available fuels. With that done, you can be sure of reliable performance, durability, and low maintenance by entrusting your requirements to Combustion Engineering. For embodied in each of these three designs are all the "know how" and experience gained from the installation of nearly 19,000 stokers of every type, above residence size, to serve more than 5,000,000 rated boiler horse power.

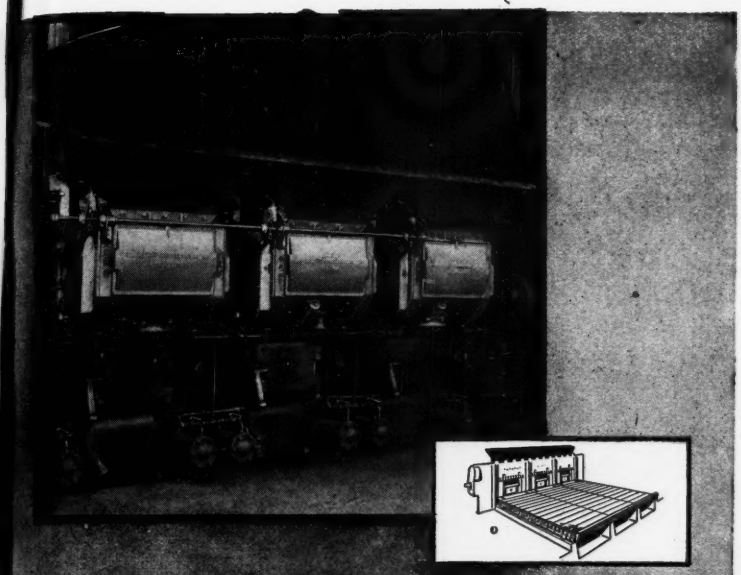
Comprehensive as these three types are, the C-E line includes other designs which round out the most complete line of stokers offered by anybody anywhere. So if your installation falls outside the 90% and within the remaining 10%, you will certainly find the answer to your needs among modern C-E designs of Multiple Retort, Traveling Grate, and Chain Grate Stokers.

It is none too soon to plan your new installation or to modernize your present plant. A C-E engineer will be glad to discuss your problem with you. A-829A

COMBUSTION ENGINEERING

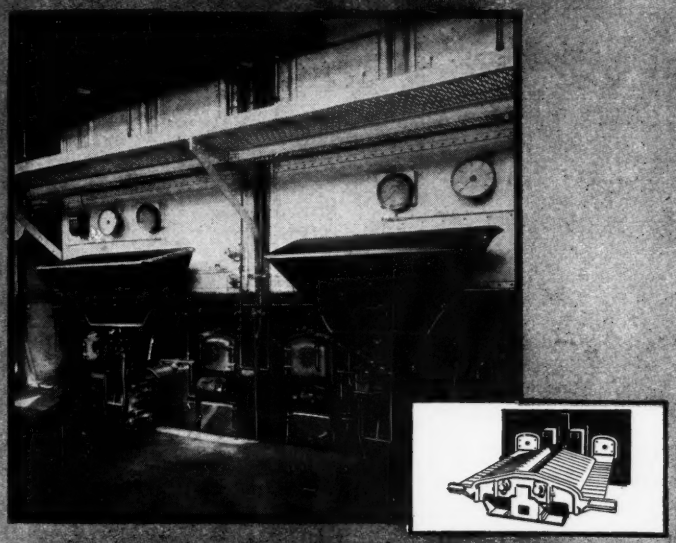
200 MADISON AVENUE · NEW YORK 16, N. Y.

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



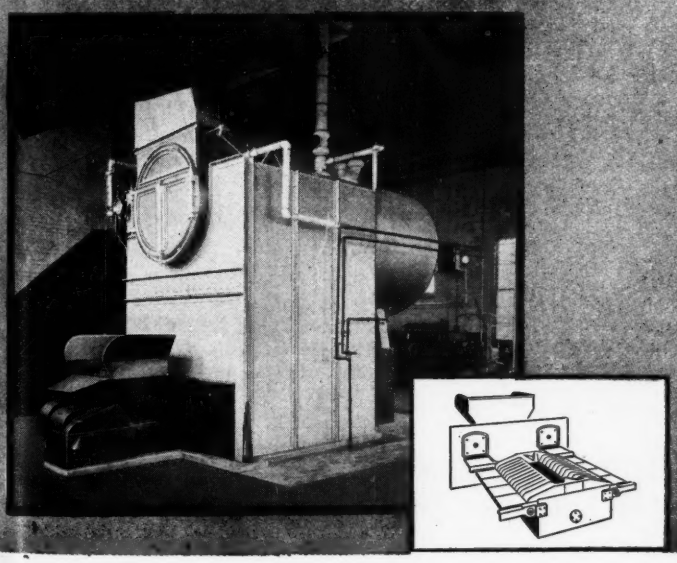
SPREADER—Overfeed

Approximate Application Range — 150 boiler hp to largest units suitable for stoker firing. A simple, rugged stoker designed to burn a wider variety of fuels than any other type of mechanical firing. Hopper, feeding and distributing mechanism, variable-speed drive and motor are combined in a compact unit. Rotating spreader blades feed coal into the furnace in crisscrossing streams which assure uniform distribution. Fines are burned in suspension and the rest of the coal is burned on a grate — stationary or dumping type. Grate surface is zoned for regulating air admission and to facilitate cleaning.



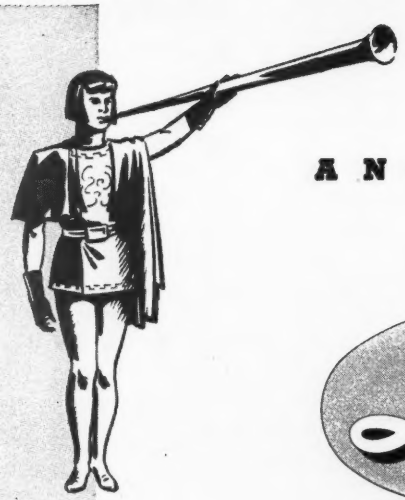
TYPE E—Underfeed

Approximate Application Range — 150 to 600 boiler hp. A single-retort, underfeed stoker designed to burn a wide variety of bituminous coals. Ram feed is supplemented by a reciprocating sliding bottom. Grate surface consists of hollow, air-cooled grate bars, alternately fixed and moving, to condition the fuel bed and assure its steady movement toward the dump trays. Air supply under zoned control with provision for introducing air over the fire. Steam or hydraulic drive.



SKELLY—Underfeed

Approximate Application Range — 20 to 200 boiler hp. A compact, self-contained unit offering all the advantages of underfeed firing. Moving grate bars assure lateral distribution of fuel and maintain a clean porous fire. Cantilever dump grates of non-avalanching type simplify ash removal. Integral forced-draft fan, with vortex inlet control, permits positive regulation of air-coal ratio. Sixteen rates of coal feed through variable-speed transmission. Automatic control is standard equipment. Timken bearing equipped. Alemite lubrication throughout.



ANNOUNCING

Liquon

A NEW NAME IN

LIQUID CONDITIONING

BACKED BY A QUARTER CENTURY OF EXPERIENCE

Processes

FOR WATER CONDITIONING

Removal of

Hardness, Turbidity, Color, Odor, Taste, Iron, Silica, Oil, Total Dissolved Salts, Oxygen, Other Gases

FOR OTHER LIQUIDS

Removal of

Undesired Impurities from Syrups, Juices and Chemical Solutions

Recovery of

Valuable Substances from Solution or Suspension

Products

Chemical Products and Mechanical Equipment for Water Conditioning for Household, Industrial and Municipal Use; also for Conditioning of Other Liquids:

Cation and Anion Exchangers
Zeolite Water Softeners
Ion Exchange Equipment
Demineralizing Equipment
Filtration Equipment
Diatomite Filters
Chemical Feeds
Sludge Blanket Units
Cold Lime-Soda Softeners
Hot Process Softeners
Continuous Blowoff Systems
Deaerating Heaters
Vacuum Deaerators

● **If you need soft water . . . clear water . . . pure water . . . or purification of other liquids . . . this announcement is important to YOU.**

LIQUID CONDITIONING CORPORATION is a new organization, operated by pioneering experts in liquid conditioning with more than a quarter century of experience in this field.

- The newness of the LIQUON organization means freedom from hide-bound procedure in the approach to and handling of your liquid-conditioning problems.
- The long experience of LIQUON engineers and chemists means full assurance that your problems will be correctly solved. Many modern methods which are now accepted as standard in the art were pioneered by members of this organization.
- LIQUON services are COMPLETE. They include every process . . . apparatus . . . material . . . for any requirement of liquid conditioning.
- Therefore, LIQUON recommendations are authoritative and impartial. Each LIQUON installation is custom-tailored for best results with your precise conditions. And each carries our overall guarantee of performance.

These are the reasons why this announcement is of significance to you . . . why you should consult LIQUID CONDITIONING CORPORATION on your problems concerning water and other liquids.

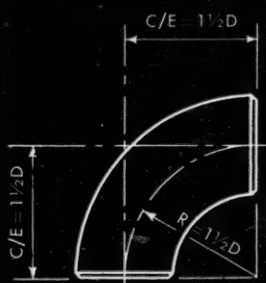
●

Write us today. Your inquiry will not involve the slightest obligation to you, and may result in important benefits and savings in your plant.

LIQUID CONDITIONING CORPORATION
423 West 126th Street, New York 27, N. Y.

ONLY MIDWEST OFFERS A COMPLETE SELECTION OF 90° WELDING ELBOWS

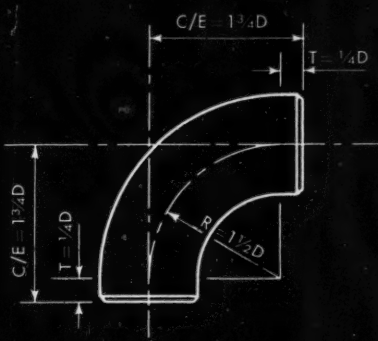
1 LONG RADIUS AMERICAN STANDARD



SIZES: 3/4" TO 12", INCLUSIVE

All dimensions conform to the American Standard for Steel Butt-Welding Fittings ASA B16.9. Unless order specifies otherwise, these "ASA Elbows" will be furnished.

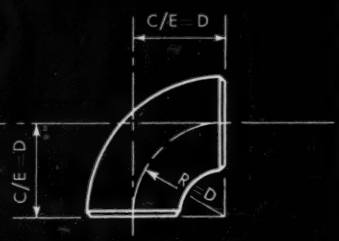
2 LONG RADIUS LONG TANGENT



SIZES: 2" TO 20", INCLUSIVE

Same radius as "ASA Elbows" but with long integral tangent on each end—an exclusive Midwest feature that saves time and pipe, and sometimes eliminates an extra weld.

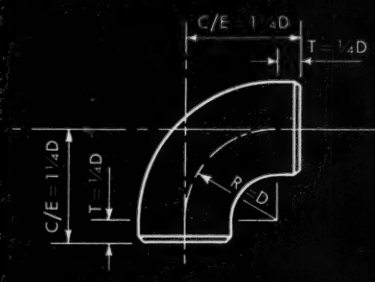
3 SHORT RADIUS



SIZES: 1" TO 12", INCLUSIVE

Where space limitations prevent the use of "ASA Elbows" or Midwest "Long Tangent" Elbows shown at left, these short turn elbows without tangents are recommended.

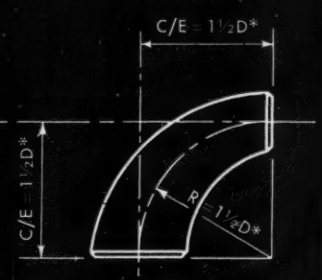
4 SHORT RADIUS LONG TANGENT



SIZES: 14" TO 24", INCLUSIVE

These OD sizes are short radius but have the exclusive Midwest long tangents that save pipe and make it possible to line up the fitting and pipe more quickly and accurately.

5 LONG RADIUS REDUCING



SIZES: 2" TO 12"*, INCLUSIVE

Only Midwest makes the reducing welding elbow which takes the place of a straight elbow and a reducer. It eliminates one weld, cuts installation cost, and reduces pressure drop.

SYMBOLS:

- C E = Center-to-End Dimension
- D = Normal Pipe Size
- R = Radius
- T = Length of Tangent
- *D = Dimension is Larger Pipe Size

MIDWEST WELDING FITTINGS IMPROVE DESIGN AND REDUCE PIPING COSTS
MIDWEST
RIPING & SUPPLY CO., Inc.
Main Office: 1430 South Second St.
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The Only Complete Metal Gasket Line

gives you

4 Real Advantages

- **You get the *right* gasket for every application — not one that's *nearly* right.**
- **You get the benefit of complete laboratory and research facilities to assure you of 100% joint efficiency.**
- **You avoid unnecessary gasket troubles because Goetze can supply the most efficient and durable gasket for your particular conditions of temperature and pressure.**
- **You get the services of qualified Goetze representatives in 18 cities.**

Specifications, engineering data and drawings of the Goetze line — the only complete line of gaskets — are available in Catalog No. 53. If you do not have a copy on file, send for one on your company letterhead. Or consult the nearest Goetze representative for efficient gasket service.

TECHNICAL BULLETINS

Ask to have your name added to the list of engineers receiving "The Gasket" — a series of technical bulletins containing original and useful gasket information from the Goetze Research Laboratory. Write on your company letterhead giving your position.

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	Toronto	Syracuse	

Goetze for GASKETS

"America's Oldest and Largest Industrial Gasket Manufacturer"

perfect – 17 years ago –

STILL BETTER TODAY

Won't Clog on Wet Coal!

Feed this stoker the lowest available grade of coal! Watch it operate perfectly—without clogging—on *any* grade—wet, dry, or partially frozen. This "non-clog" feature is *exclusive* with Perfect Spread.

PERFECT SPREAD STOKER

discharge—up to 400,000 lbs. of steam per hour.

"Something new has been added!" Today's Perfect Spread Stoker, using the same successful principle of operation which distinguished its 17 years of operation, has been re-designed, streamlined, improved.

It combines features not obtainable in any other stoker. It handles all types of coal—efficiently, economically.

The pleasing, easy-to-clean exterior is indicative of its dependable, quiet operation which brings you both fuel and maintenance savings.

Before you buy any fuel firing equipment, investigate the Perfect Spread Stoker. Write today for descriptive booklet giving *all* the facts!

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AMERICAN ENGINEERING COMPANY

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For MAXIMUM BREAK-UP at LOWEST PRESSURE

install MARLEY NON-CLOG SPRAY NOZZLES

Spray efficiency depends on break-up . . . operating economy on pressure required and nozzle durability . . . installation cost on number of nozzles required. Marley Patented Spray Nozzles continually deliver greatest volume per nozzle with most complete break-up at lowest pressure. For any specified capacity and performance fewer Marley nozzles are required.

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for
COOLING TOWERS
SPRAY PONDS
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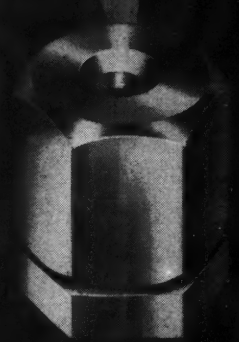

Atomizing
for
HUMIDIFYING
VAPORIZING
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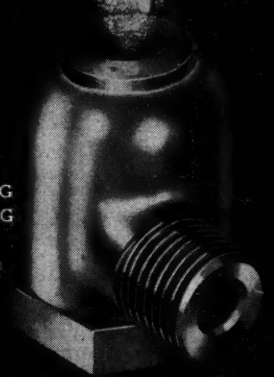

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ALL SPRAYING
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THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS

WHIRLWIN POWER

The Hendy turbine is the last word in power... streamlined, up-to-the-minute design in every detail... features born of war-experience and proven in use in the field... and above all, top performance at low cost. Write for Literature describing Hendy steam turbines and turbo-generators. 200 kw. to 7,500 kw.

Power by Hendy

ENGINEERED TO SUIT YOUR NEEDS

Joshua Hendy Iron Works, Est. 1856
Plants: Sunnyvale and Torrance, California.
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Sales offices: Boston, Buffalo, Chicago, Cincinnati,
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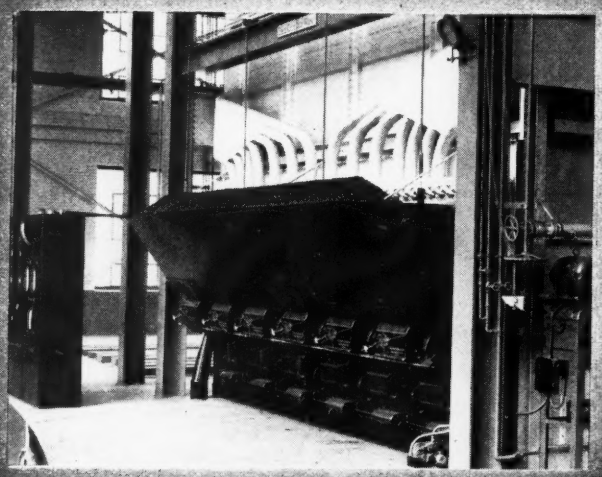
HOFFMAN

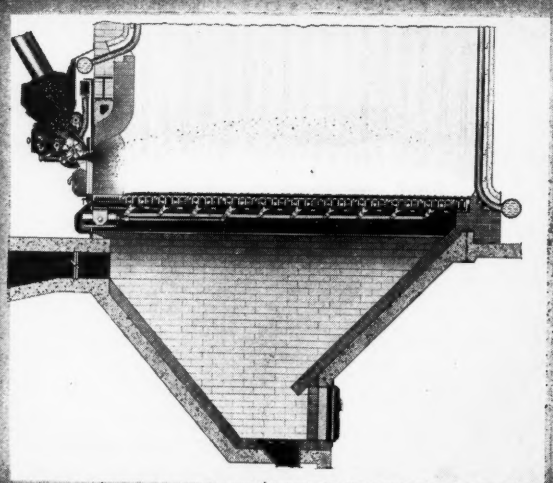


by the revolving impeller mechanism and delivered to the furnace, uniform distribution being assured by means of the unique curvature of the impeller blades.

MANUAL ADJUSTMENTS. Quick manual adjustments are provided to maintain uniform speed over wide variations in sizes and surface moisture content of the coal supply.

Dumping Grates, either power or manually operated, will fit any furnace width, due to the flexible design.

In laying out a furnace arrangement, first determine the proper width of grates and then determine the length by increments of 18 inches to obtain suitable projected area for correct combustion rates.



HOFFMAN COMBUSTION

WORKS AT: FAIRMONT, WEST VIRGINIA
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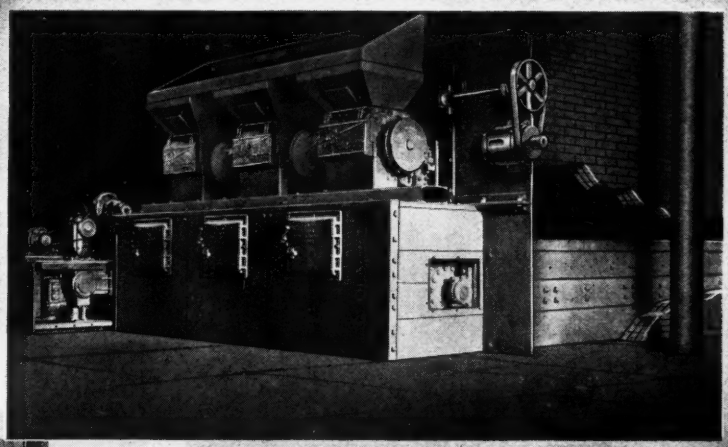
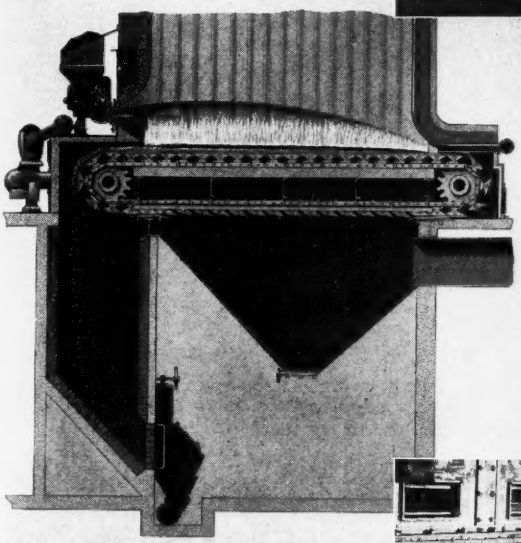
STOKERS

Firite

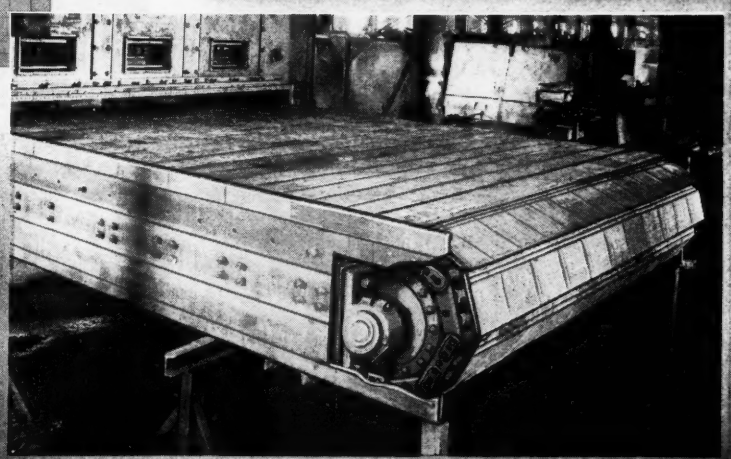
Hoffman Firite Spreader Type Stokers equipped with Hoffman Continuous Ash Discharge Grates, may be designed for either front or rear discharge to suit local plant conditions.





- Expansion and permanent growth of grate structures due to furnace temperatures are absorbed in expansion joints, provided in the design.
- Any expansion in grate structure will not be transmitted to the moving carriage, due to the method of mounting.
- Grate and fuel bed load is not carried on chain and sprockets.
- Hoffman C-A-D grates may be installed to discharge at either front or rear.

- Unique air entry through the lower strand.
- Uniform air pressures under all parts of upper strand.
- Positive air seals, both front and rear . . . that work.
- Effective air seals between grate bar sections.
- Minimum heat conductivity from fuel bed to carriage.



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Conseco Bevel Gear Universal Joints give you positive remote control of inaccessible or widely separated equipment at any angle from 0° to 135° on vertical centers. Gears are precision machine cut manganese bronze, assuring efficient, dependable performance under severe conditions. Capacities range from 1580 to 4938 inch pounds at 49 rpm. Standard diameters of shafts are ½", ¾", 1", 1¼" and 1½".

Examine a set of Conseco Bevel Gear Universal Joints and you will see why more of them are in use than any other gear. Our engineers will help you with your torque transmission problem without obligation. Send for Bulletin CS10.

CONSECO

BEVEL GEAR UNIVERSAL JOINTS

A highly skilled, specially equipped service organization, ready for immediate action anywhere on the continent, backed by engineering and manufacturing facilities producing over 3,000,000 sq. ft. of heat exchangers annually.

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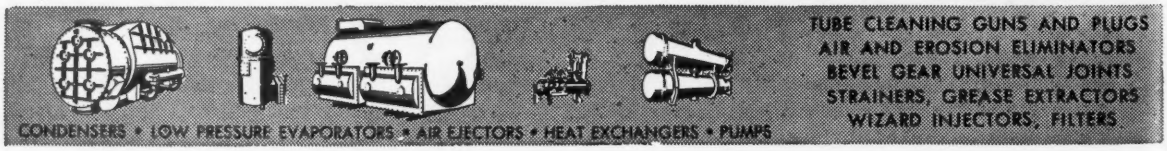

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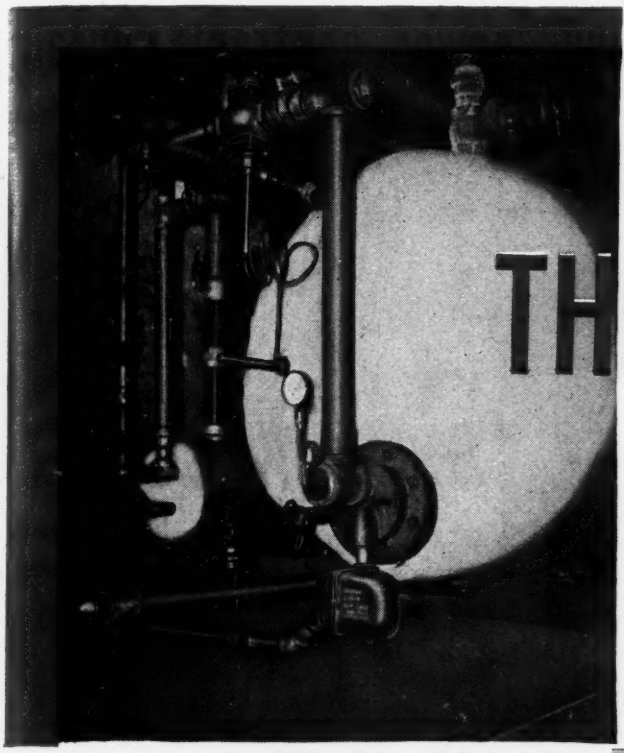


THE LUXURY

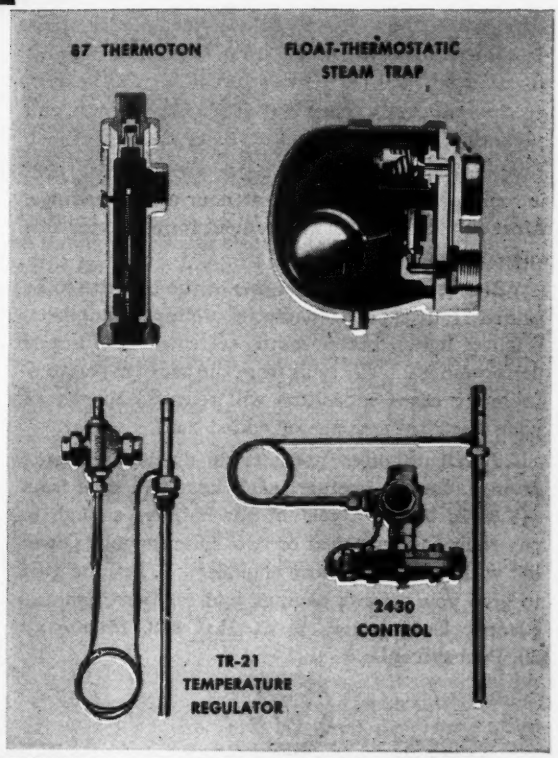
AND ECONOMY *of Correct Temperatures* AT LESS COST

This is the story of a Maintenance Engineer who has ceased to worry about heating and hot water temperatures because he knows how to use the various forms of Sarco steam traps and temperature control.

The large storage heater is controlled by the Sarco TR 21 Temperature Regulator and drained by the Sarco Float-thermostatic trap shown at right. At the rear is a hot water converter for the heating system held to exact temperature by a Sarco 2430 temperature regulator.

At other points the low cost Sarco 87 Thermoton is used to insure correct temperatures for food warming and satisfactory temperatures on incidental showers served by instantaneous heaters. In fact, Sarco is now standard throughout the shops, office and real estate holdings. It's a case where Sarco products work together as a team to produce permanent satisfaction and savings. All this engineer had to do in the beginning was to make one phone call—to the local Sarco representative.

132



SARCO SAVES STEAM

SARCO COMPANY, INC.
Represented in Principal Cities
475 FIFTH AVE., NEW YORK 17, N. Y.
SARCO CANADA, LTD., TORONTO 1, ONTARIO

Does your power contract contain a clause...

like this?

POWER FACTOR BONUS—credit for power factor maintained at or above a predetermined value.

...or this?

KVA DEMAND RATE—power rate determined by the KVA demand.

...or this?

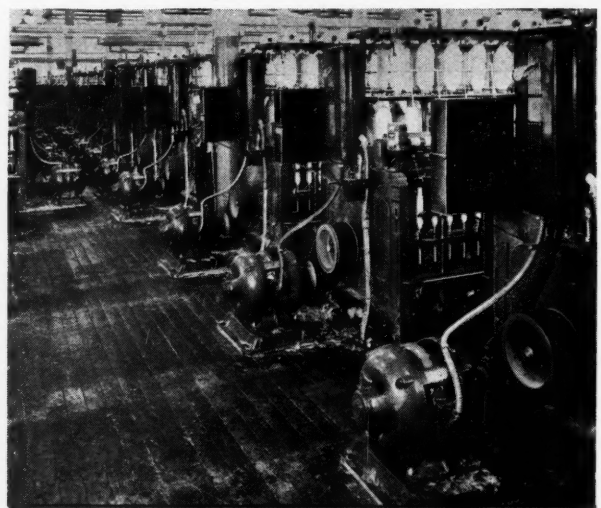
PENALTY FOR LOW POWER FACTOR—billing rate increased for power factor below a predetermined value.

If your plant load is made up of inductive apparatus such as motors, welders and induction heating equipment : : : Westinghouse capacitors can probably reduce your power costs.

Apparatus such as this draws more current than is represented by the kilowatthour meter readings. Most utilities offer an inducement for removing this current from their circuits.

"Billing savings" is just one of the benefits to be gained from capacitors. Better voltage regulation, brighter lights, better motor starting and running performance . . . all result from the use of capacitors. In many cases capacitors will release capacity of your electrical system for added load.

Capacitors offer predictable dollar-and-cents savings. On the average, each kvar will save from $18.00 to $35.00 a year in power bills—enough to pay their cost in a year or two. Discuss your power bill with a Westinghouse engineer . . . he'll be glad to give you definite savings figures. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-60637



In this large outside mill, power-factor improvement is provided by an individual dust-tight Westinghouse capacitor with each spinning frame motor. Motor control also connects and disconnects capacitors.

Westinghouse Inerteen Capacitors are fireproof and have hermetically-sealed, welded steel cases. The exclusive "Solder-Seal" bushing eliminates the need for gum or gaskets and assures a permanent seal. There's nothing to wear out.

Westinghouse

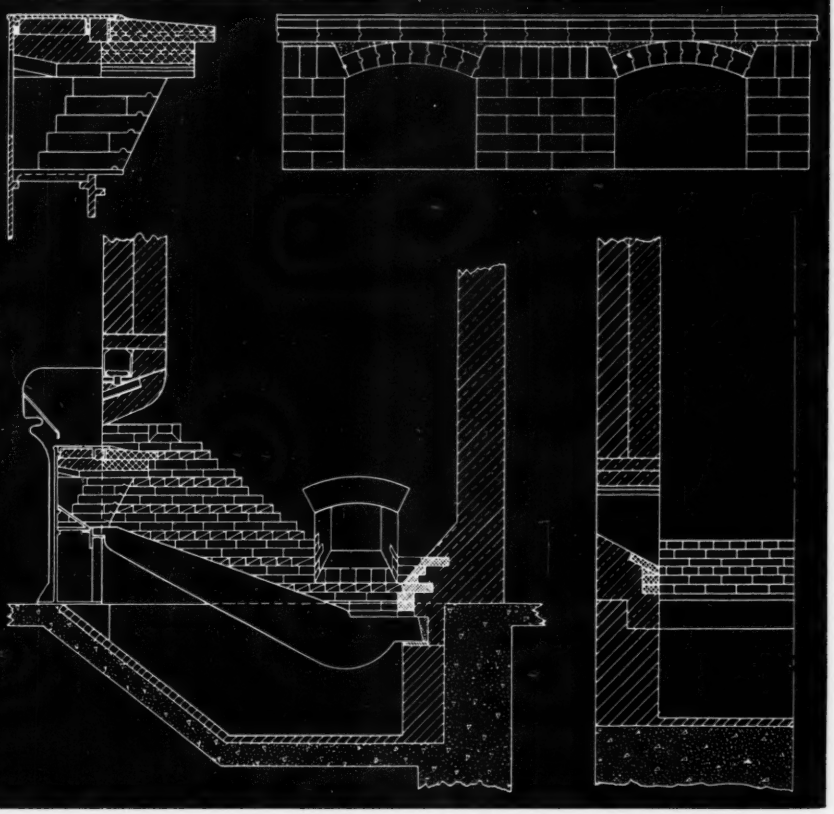
PLANTS IN 25 CITIES... OFFICES EVERYWHERE

Capacitors

WALL BRICK DATA

HUBER STOKER

This lining *Increases Capacity* *Lowers Cost*



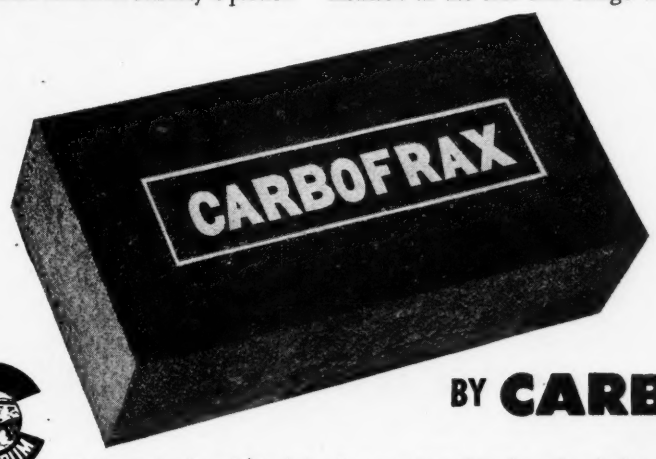
Overall efficiency is greatly improved when Huber stoker fired boiler furnaces are equipped with CARBOFRAX silicon carbide linings. A typical installation, which may be changed to meet individual plant conditions, is shown by the illustration.

Constructed of rugged interlocking CARBOFRAX shapes, the coking shelf provides longer trouble-free service. Its exceptional structural stability is particularly resistant to the mechanical abuse encountered. The abrasive action of the fuel is successfully resisted by the hard, dense surface of the CARBOFRAX shelf tile. They also eliminate carbon penetration with its attendant difficulties. Softening and subsequent sagging of the coking shelf is avoided by the high refractoriness characteristic of the CARBOFRAX shapes.

Installed in the side and bridge walls, CARBOFRAX brick prevent large clinker formations As these brick do not soften, clinkers have no opportunity to become embedded. The walls remain relatively clean. Fuel burns more effectively over the entire grate area resulting in more steam production. Stoker operation is improved—is much more efficient.

With the longer lasting CARBOFRAX lining maintenance is negligible. Repair and replacement costs are slashed. Outages for setting repair are rare. Continuous on-line service with increased steam output is assured.

These and many additional advantages make the selection and installation of a CARBOFRAX lining a "must" in engineering for greater production and economy. That is why it pays to get all the technical facts. They are clearly illustrated in our booklet on CARBOFRAX settings. For your copy simply write Dept. H-96, The Carborundum Company, Refractories Division, Perth Amboy, New Jersey.



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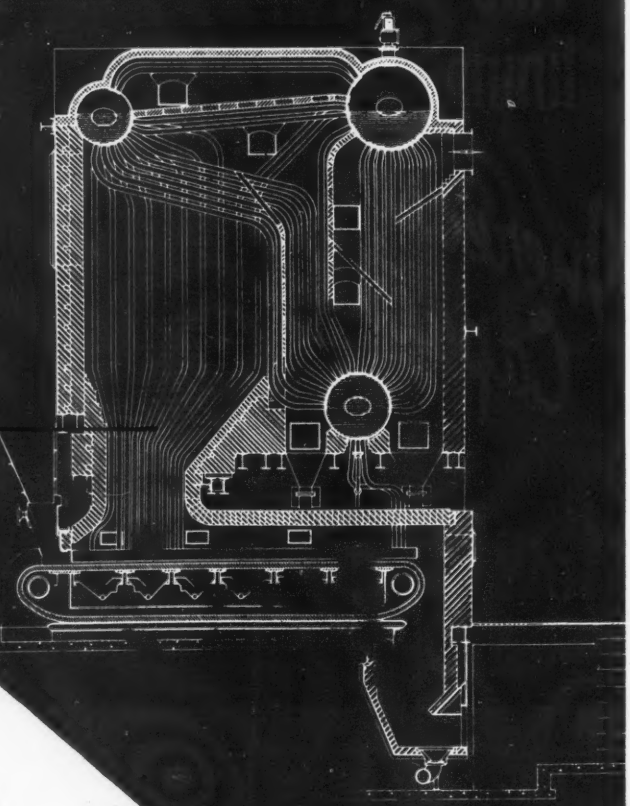
Here's how you benefit...

with the

Edge Moor Radiant Boiler



This Traveling Grate Stoker Fired Edge Moor Radiant Heat Boiler is one of two units—each producing 30,000 lbs. steam per hour at a pressure of 250 lbs. in an eastern industrial power plant.

When modernizing present boiler facilities, or building new plants, it will pay you to consider the features of Edge Moor Radiant design. For instance, examine the following:

★ Design flexibility allows the most favorable use of available building space.

★ Ability proved in years of service to steam quickly and to deliver continuous high ratings.

★ 3-drum arrangement provides for large water storage space, a generous steam liberation surface and a quiet offtake drum.

★ Furnace cooling is arranged for the minimum of maintenance as well as efficient operation with the particular fuel to be used.

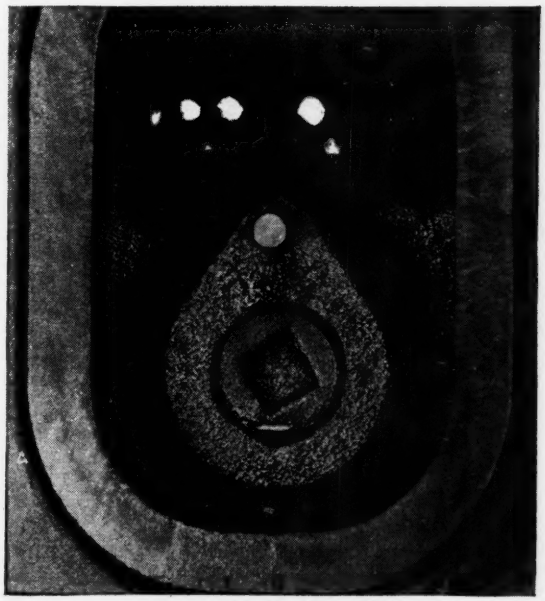
Edge Moor Radiant Heat Boilers are available in a wide range of capacities, pressures and total temperature requirements. They are adaptable to all fuels and can be supplied with all boiler auxiliaries.

EDGE MOOR IRON WORKS, INC. • Main Office and Works, Edge Moor, Del. BRANCH OFFICES AND AGENTS: 95 River St., Hoboken, N. J. • 7 Water St., Boston, Mass. • P.O. Box 9, Station E, Atlanta, Ga. • 2459 Woodward Ave., Detroit, Mich. • One N. LaSalle St., Chicago, Ill. • 2295 University Ave., Saint Paul, Minn. • 623 Aztec Building, San Antonio 5, Tex. •

edge moor steam generating equipment

EM

Diesel Engine DANGER points



Air ports clogged after operation on uncompounded oil.

Clogged Ports Reduce Efficiency

To the operator of a two-cycle Diesel engine, the clogging of air ports can become a serious problem. Deposits on air ports are composed largely of fuel soot and oxidized products. These contaminants reach the lower cylinder when sluggish or stuck piston rings permit blow-by.

RPM DELO Oil Prevents Air Port Deposits

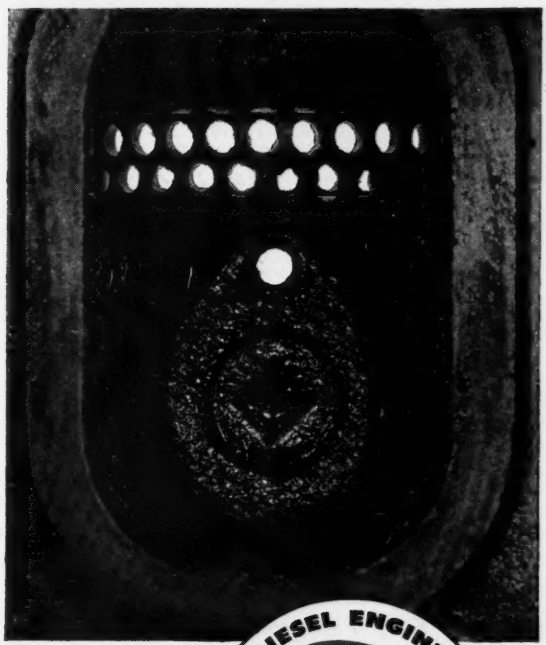
RPM DELO Oil keeps air ports clean three ways:

1. By reducing ring wear (RPM DELO Oil is compounded to cling to scorching wear points which most oils leave bare).

2. By preventing ring-sticking (a detergent in RPM DELO Oil eliminates the deposits which stick rings).

3. By preventing oxidation of the oil (RPM DELO Oil's anti-oxidant compound controls the gummy substances which act as a binder for deposits).

How RPM DELO Oil keeps air ports open.



To match the fine performance of RPM DELO OIL, use these equally efficient companion products from the same famous "RPM" line—RPM HEAVY DUTY MOTOR OIL —RPM COMPOUNDED MOTOR OIL—RPM GEAR OILS AND LUBRICANTS—RPM GREASES. For additional information or name of your distributor, write any of the companies below:

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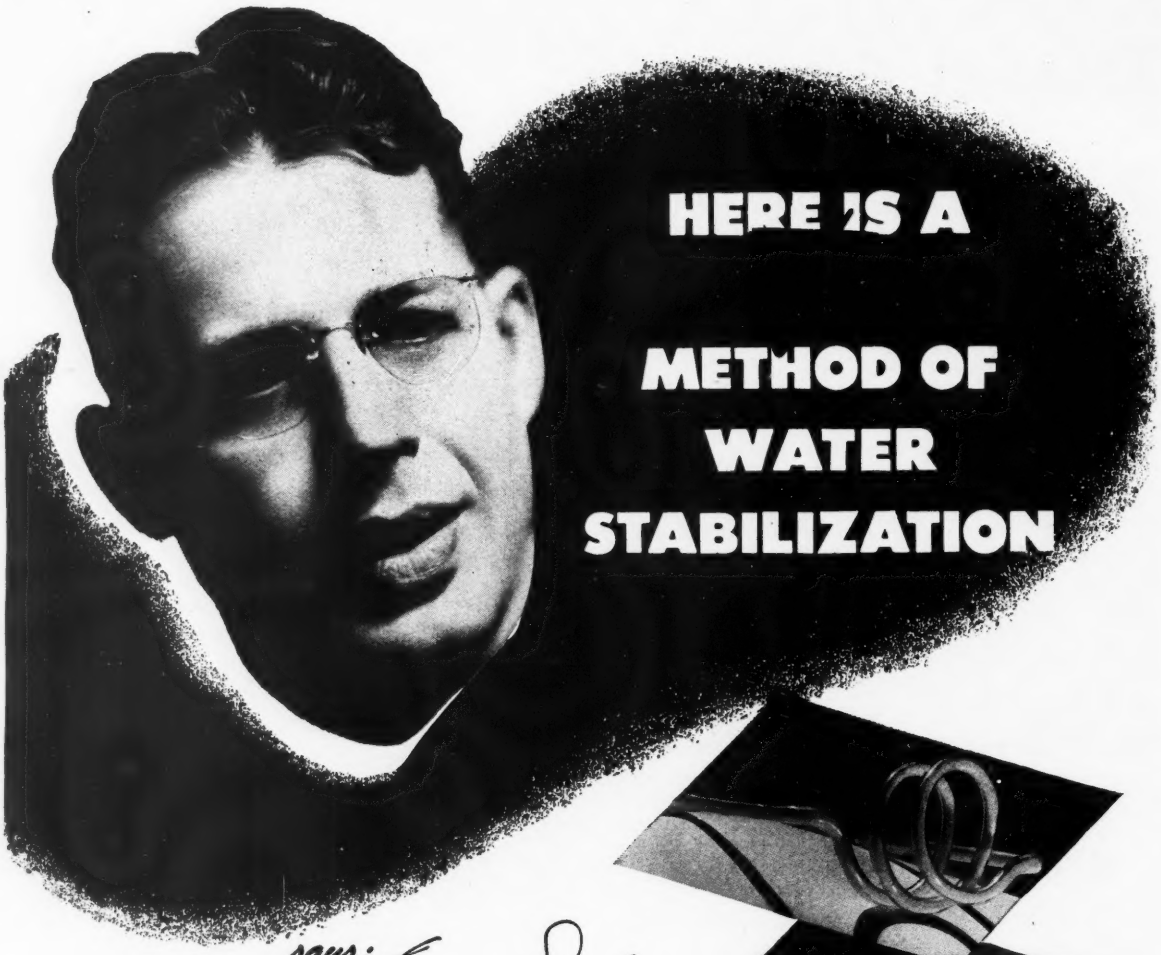
THE CALIFORNIA COMPANY • 17th and Stout Streets, Denver 1, Colorado
STANDARD OIL COMPANY OF TEXAS • El Paso, Texas
THE CALIFORNIA OIL COMPANY • 30 Rockefeller Plaza, New York 20

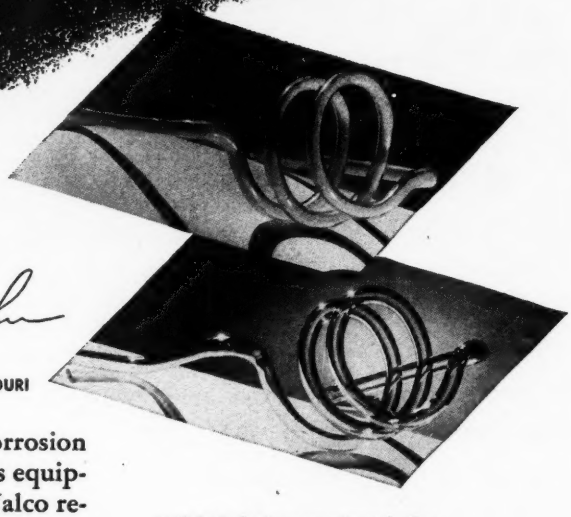
DIESEL ENGINE RPM DELO LUBRICATING OIL



HERE IS A METHOD OF WATER STABILIZATION

says: Eugene Diehm

NALCO REPRESENTATIVE, KANSAS CITY, MISSOURI



Stabilizing water to prevent scaling and corrosion in water lines, heat exchangers and process equipment is a Nalco specialty... And endless Nalco research and experimentation have uncovered only one positive method of stabilization: Plant surveys to determine operating and water conditions, followed by Nalco Laboratory recommendations for specific water treatment to meet the exact needs of the individual plant.

A new Nalco Stabilization Bulletin gives full information on the factors contributing to unstable water... tells how the Nalco System can operate in your plant to provide positive stabilization. Write for your copy today.

NATIONAL ALUMINATE CORPORATION
6224 W. 66th PLACE • CHICAGO 38, ILLINOIS

Canadian inquiries should be addressed to Aluminate Chemicals, Ltd., 555 Eastern Avenue, Toronto, Ontario.

- *Nalco Laboratory experimental coil at top shows the scaling effect of untreated hot water passing through feed lines.*
- *Coil at bottom is still sparkling clean after handling the same amount of the same water under the same conditions, but following Nalco individualized stabilization treatment.*

NALCO—The Scientific System of Water Treatment for All Industry

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

AUXILIARIES

1 **Stoker Specification Sheet**—Bulletin 608, six pages, gives the mechanical details and specifications of these stokers, shows how exclusive principles save fuel and money, presents a check list of 11 advantages accruing from this construction. Two line drawings are used to give dimensions of the units. Whiting Stoker Sales Co.

2 **Deaerators Booklet**—Publication 4160, 20 pages, covers the company's atomizing deaerators. A two-color, sectional line drawing is used in the front of the booklet to illustrate principle of operation, water flow and steam flow. A discussion of the advantages peculiar to the atomizing and to the tray type deaerators is presented to assist a specifier in making selections. Applications of the unit are included and a section of the book shows how it was made an integral part of hot process softeners. Accessories are shown and described. Cochrane Corp.

3 **Desuperheater Bulletin**—This 4-page Bulletin U-1 covers the manufacturer's cartridge type desuperheater. A big section of the bulletin is used to tell how the desuperheater works. A typical arrangement of desuperheater and controller is shown in a drawing and a recording chart shows how the desuperheater maintains uniform temperatures. Sizes and materials are explained and a table of dimensions for three different series is presented. Elliott Company.

4 **Refractory Cement**—This Bulletin 322-D tells about Q-Chrome, a neutral base refractory cement for furnace construction and maintenance. Sections in the bulletin point out how the cement works—how it bonds clear through the wall; its high heat resistance; how it stays in suspension; etc. Photographs are used to emphasize certain points. Uses of the cement in gas plants, power plants, and other industries are stated. Quigley Company, Inc.

5 **Low Pressure Evaporators**—This 12-page bulletin covers the company's line of low pressure evaporators. The fore part of the booklet explains the difference between film type, submerged tube type and other types of evaporator plants. Advantages of the low pressure submerged type are explained with tables and engineering data. Installation diagrams are an important part of the booklet; these are printed in two colors. Typical installations are shown in photos and the company's maintenance service is explained. Condenser Service and Engineering Co., Inc.

6 **Stoker Installations**—This 36-page, paper-bound booklet is exclusively devoted to installation data and photos—all based on actual installations. Features of the stoker are stressed by means of these photos and by line drawings; their application and adaptability to various conditions is pointed out. Detroit Stoker Company.

ELECTRICAL

7 **Bus Duct Handbook**—This new data book, B-3714, 40 pages, has been designed to aid in the selection and application of a bus duct system which will provide flexible, accessible power in industrial plants. The booklet diagrams and analyzes step-by-step installation of three typical bus duct layouts. Drawings and photos of the duct components illustrate the ease of installation, sturdy construction and trouble-free design of the equipment. The engineering data section of the booklet includes standard ratings of main breakers, temperature conversion tables, formulas for determining amperes, horsepower, kilowatts and kilovolt-amperes, load power factor curves and other information. Westinghouse Electric Corp.

8 **Insulators Handbook**—This 48-page, paper-bound, thumb-indexed handbook covers the company's complete line of insulators; it is designated as Catalog 2000. Each of the various types of insulators has several pages devoted to its description; there are pillar insulators, bushings, coaxial cable insulators, lead-in insulators, spreader and strain insulators, coil forms, miscellaneous and special insulators. The back section of the booklet is filled with design criteria—tables of tolerances, line drawings and miscellaneous information. General Ceramics.

9 **Wire Stringing Bulletin**—Clear and simple instructions for wire stretching and stringing are provided in a new bulletin just issued by this company. The bulletin is amply illustrated with diagrams and also presents engineering information, for security, efficiency and savings. W. C. Dillon & Co.

10 **Buying Guide Handbook**—Here is a 16-page handbook designed to be of genuine help to the reader in selecting any of a complete range of industrial products including motors, motor controls, power generation and distribution equipment, vibrating screens, feeders, blowers and compressors, V-belt drives, electronic heating and welding equipment. The booklet leads off with suggestions of primary decisions which must be made by the prospect in narrowing down the problem. For instance "Which Motor Shall I Buy?" instructs prospects to figure characteristics, speed and hp ratings needed, and what torque requirements will be. Next, decide type of motor, open, enclosed or splash-proof. Bulletin number is 25B6177B. Allis-Chalmers Mfg. Co.

11 **A-C Generator Bulletin**—Pub. No. 186 tells all about this new generator "with the built-in regulating current that automatically holds steady voltage." It is a six-page bulletin. One feature of the booklet is the section which tells how the Regulectric works. Operating elements of the generator are shown in a wiring diagram. Simplicity of installation and a listing of outstanding advantages are other features. The back page of the folder shows the various parts of the generator. Electric Machinery Mfg. Co.

DIESEL

12 **Diesel Engine Engineering Information**—These three bulletins—L-31, L-32, and L-51—describe respectively: the company's stationary Diesel; the supercharged stationary; and the gas-Diesel. Each of the four is printed in two colors and is crammed with engineering information, specifications, charts, weights and shipping information. The Cooper-Bessemer Corp.

13 **Diesel Engines**—This general catalog on the company's Diesel engines—Catalog 192—is a 24-page piece of literature and is profusely illustrated and well arranged. Specific advantages of the units are listed in the front of the booklet and their diversified applications are explained. The company points out the advantages of its "turbocharging" feature and shows how much more power can be obtained for less fuel. Other features which are highlighted are strength and compactness, light weight, precision machining of parts, interchangeability of parts, and long life. Enterprise Engine & Foundry Co.

WATER TREATMENT

14 **Control of Fouling Organisms**—Titled "Control of Fouling Organisms in Fresh and Salt Water Circuits," by John G. Dobson, this 20-page reprint of a paper presented at the annual meeting of the ASME, describes the difficulties encountered by industrial water users due to fouling organisms such as mussels, sponges, barnacles, etc. The paper goes on to show how various control methods have met with varying success and the results of these methods are listed and charted. A complete bibliography is included. Wallace & Tiernan.

15 **Boiler Rust Treatment**—This four-page bulletin describes the company's "Rustoff" chemical which is said to "build resistance to rust- and scale-corroded and congested pipes." The bulletin tells how the treatment works and what results may be expected from its use. A brief description of the company's service department is included. Dominion Chemical Co., Inc.

16 **Zeolite Softener Handbook**—Manual, semi-automatic and full automatic zeolite water softeners are covered in this bulletin, Form 315. The booklet is divided into sections which assist in a clear understanding of the product. The water softener plant is first discussed and then operating cycles and plant supervision are considered. "Selecting Manual or Automatic Equipment," is the title of the next section; this is accompanied by a table of comparison data. Individual parts of the units are then described and illustrated. A useful section of the manual is a two-page section of tabular material and a zeolite nomographic chart. Graver Tank & Mfg. Co., Inc.

17 **Water Conditioning Service**—This new booklet, "The Six Fundamentals of Betz Water Conditioning Service," illustrates and describes how this company extends a supervisory service for boiler water conditioning. It outlines step-by-step the procedure the firm follows to give its clients trouble-free boiler plant operation. There are 16 pages in the booklet and two of them are devoted to each of the following fundamentals: "Complete Plant Investigation and Report," "Establishment of Plant Control," "Daily Plant Control Tests," "Detailed Review of Plant Tests and Report," "Complete Laboratory Analyses," and "Periodic 'Check-Up' Visits." W. H. & L. D. Betz.

18 **Softener, Filter Valve Control**—Here is a new booklet which describes a master valve control for gravity and large size pressure filters or zeolite softeners. The booklet shows that, through automatic control, which is made possible by the use of a master valve it is possible to regulate the rate of flow, prevent waste of water in the operation of backwashing and rinsing. It is also possible to maintain the zeolite or sand bed in clean, active condition. Permutit Company.

19 **Water Treatment**—Necessity for correct boiler water treatment, and a listing of the advantages obtainable with clean water are described in this bulletin. The costly results of lack of conditioning are shown. Alken-Murray Corporation.

PUMPS

20 **High-Pressure Centrifugal Pumps**—Bulletin C-945 covers this company's horizontal split case, multi-stage, high pressure centrifugal pumps. There are eight pages in the bulletin. Applications of the pumps are detailed and a section of the bulletin tells all about the details of construction. Important features of the pump take up another section of the catalog. One full-page selection table adds considerably to the usefulness of the booklet. Economy Pumps, Inc.

SEPTEMBER, 1946

POWER PLANT ENGINEERING
53 W. Jackson Blvd.
Chicago 4, Illinois

Please have the manufacturers send me without obligation the literature indicated by the following paragraph number.

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Your Name .....

Your Title .....

Your Company Name .....

Company Address .....

City ..... State .....

(If you prefer delivery at your home also fill in below)

Home Address .....

City ..... State .....

21 **Centrifugal Pumps Handbook**—Form 7062 is a two-color, 16-page booklet well illustrated with cut-away views of two-stage centrifugal pumps, types of drives, typical installations. There are tables of performance, dimensions and pipe friction. An exceedingly useful section of the book is a typical pumping problem which is worked out in detail. The pumps described are specifically for use in condensate service in power plants, feed water service for boiler pressures from 100 to 300 psi, and for general use in many industrial plants and industries. Ingersoll-Rand Co.

22 **Centrifugal Pumps Bulletin**—Bulletin 200 is a recently-issued 8-page number describing a new line of centrifugal pumps ranging in capacity from 40 to 900 gpm and heads up to 200 ft or higher. Included in the bulletin are details of the hydraulic design which, the manufacturer says, results in higher pumping efficiencies for all classes of general service. Engineering information includes selection tables, friction tables and a section on "How to Secure Low Pumping Costs." Carver Pump Co.

23 **Steam Pumps Specifications Bulletin**—Bulletin 229 Revised is completely devoted to a description, specification listing and illustration of the company's two stage volute centrifugal pump. One full page is used to list specifications of casing, impellers, shaft, shaft sleeves, case rings, etc. A sectional view of the pump is used as a vehicle for labeling the parts of the unit and another page consists of a dimensioned drawing accompanied by a dimension table and a rating table. Warren Steam Pump Co.

PIPE, VALVES

24 **Free Chart of Pipe and Fittings Materials**—Engineers, draftsmen, purchasing agents and others concerned with the design, layout, erection or buying of piping systems will welcome this handy, new chart of pipe and fitting materials. It deals with carbon, intermediate alloy, stainless and other special analysis steels, and covers ASTM specifications, chemistry, service limitations and welding procedures. The 9 by 14 in. chart folds to 8½ by 11 in. and fits easily into a letter-size filing cabinet. Tube Turns, Inc.

25 **Corrosion Resistant Valves**—Two bulletins, both of them on corrosion resistant valves have just been issued. One of them, a technical information bulletin covers the mechanical properties, analysis range, applications, advantages and sizes and specifications of the valves. The other is devoted to a photographic display of the installation of the valves. Alloy Steel Products Co.

26 **Mechanical Goggle Valves Booklet**—The company calls attention to the fact that its mechanical goggle valves for use in boiler plants, coke plants, gas washers, precipitators, etc., are now available in sizes from 6 in. to 72 in. and tells about them in this new bulletin. The six-page bulletin describes the valves construction and design features and presents several line drawings which are accompanied by tabular material on sizes and dimensions. An interior view of the valve is used as a vehicle to describe simplicity of operation. Wm. M. Bailey Co.

MAINTENANCE

27 **Heavy-Duty Vacuum Cleaning**—Catalog A-546 is a 16-page booklet titled "Remove the Menace of Dust." The dangers of dust in disease, damage and destruction are stressed in the opening paragraphs and the booklet then goes on to show applications of the company's heavy-duty cleaning equipment. Principal elements of the cleaning equipment are pictured in cut-away wash drawings and photos; tools for use on every type of surface are pictured. A cross-sectional drawing of a plant shows the overall layout of a cleaning system. U. S. Hoffman Machinery Corp.

28 **Field Service Report on Steam Cleaning**—The subject of this steam cleaning field service report is to show how the company's material called "Senior" may be used in steam cleaning machines to do an effective de-greasing job. It shows how the de-greaser permits continuous operation of equipment, how it makes an instant solution, and tells of its harmless action. Direction on how to use the de-greaser are presented and a listing of the types of companies using steam cleaning equipment is given. The Penetone Company.

29 **Corrosion Prevention Handbook**—This booklet, titled "Magnesium Anodes for Cathodic Protection," is a 16-page piece excellently illustrated with understandable charts and line drawings printed in two colors. It shows the problem of corrosion as one which is preventable and then goes on to show by means of the above-mentioned drawings and charts just how corrosion may be controlled. The entire book is filled with practical suggestions and descriptive information of value to engineers. The Dow Chemical Co.

30 **Maintenance Guide**—This new, profusely illustrated maintenance guide will serve as a handy reference for guidance in solving the maintenance problems arising in the operation of power plants, water works, sewage disposal plants, incinerators, water filtration plants, etc. Dealing also with "basement to roof" building maintenance the guide will be of value to every man interested in a practical solution to these maintenance problems. Stonhard Co.

INSTRUMENTS, CONTROLS

31 **Combustion Control**—This 12-page catalog explains the reason for automatic combustion control equipment and then launches into a description of the features of this particular control. It tells about the company's "packaged" control and presents drawings showing typical hook-ups. The booklet is well illustrated with photos and diagrams. Ace Instrument Co., Inc.

32 **Water, Steam Mixer; Temperature Regulators**—This 4-page bulletin has a lot of information packed into it. The first three pages are devoted to descriptions, drawings and other illustrations of the company's steam and water mixer which is described as economically mixing, for showers and industrial cleaning, cold water with live steam. Three-color drawings show how the mixer works and roughing-in dimensions are given. The fourth page of the folder tells about temperature regulators in the company's line. The Powers Regulator Co.

33 **Specification Index for Instruments**—Bulletin W-1800 is a 24-page book which contains complete specifying information for the company's line of automatic controlling, recording and indicating instruments. The book is carefully arranged for easy reference; the index lists the equipment not only by name but by function so that the specifier is considerably aided in locating the proper instrument for the job in mind. Line drawings and photos make the description and explanatory matter easy to follow. The Bristol Company.

34 **Controlling Water Level**—Bulletin 455 is a performance report on the company's automatic flow regulating equipment installed with Combustion Engineering Type VU boiler. A photo of the actual installation is presented as are a boiler meter steam chart and a recorder chart which graphically depict the manner in which the regulator assumes fully automatic control. Northern Equipment Co.

35 **How to Control Radiant Heating**—Booklet "B" is a handbook on the various methods of controlling radiant heating. It first tells about the various types of radiant heating systems and thus shows why control is an important factor in the proper operation of these systems. A description of the various methods which can be used is then presented and another section tells about primary controls for radiant heating. "Space Controls for Radiant Heating," is the title of the next section. Still another chapter tells how forced ventilation may be added to increase or modify the radiant heating effect. Recommendations of pipe and tubing manufacturers are given. Eight blueprint-type drawings show control hookups which may be used. Johnson Service Company.

36 **Stack Waste Detector**—A new comprehensive bulletin, "How to Cut Oil Costs With Robot-Eye," has been issued. The bulletin shows how a 15 to 20 per cent reduction in fuel consumption may be realized through improved combustion efficiency and boiler heat exchange. The entire saving is said to be made from the chimney waste. The principle of "haze" control is concisely detailed and graphically illustrated. General Power Plant Corp.

POWER TRANSMISSION

37 **Flexible Couplings**—This 4-page Bulletin SL-1000-1 stresses the simplicity of design and longer life of these resilient flexible couplings. A cut-away view of the coupling explains its interior construction and is used to point out some of its structural advantages. A series of four line drawings illustrate some of the advantages of the coupling. The last page of the folder shows typical installations and also presents information—tables and line drawings—to assist in ordering. Crocker-Wheeler Electric.

38 **Power Transmission Belting**—A new 6-page folder (6-7315-GI) has been issued by this company; it covers a line of power transmission belting for drives of any size from 0.05 hp up. Besides the belting the bulletin also shows V-belt sheaves of various types. The belting is pictured as a product and also as installed in typical plants. B. F. Goodrich Co.

39 **Reduction Drives**—Catalog R-44 is a 16-page bulletin covering the construction, installation and operation of these reduction units and drives. One full-page illustration is a cut away view which depicts the interior construction of the reduction unit. Blueprint type illustrations show the installation of the drives on a revolving screen, belt conveyor, apron feeder, screw conveyor, line shaft, bucket elevator, etc. A highly useful section of the book is the one on how to select reduction drives; it is filled with tables and examples. Dimension tables and price lists round out the booklet. The American Pulley Co.

40 **Belting, Packing Handbook**—Here is a 28-page pocket-size handbook on the company's line of industrial rubber products. Listed in the booklet are flat transmission belting, conveyor belting, fractional horsepower V-belts and sheaves, multi V-belts and sheaves, all types of hose and couplings, rubber putty, packing, etc. Each page illustrates and describes at least one product and presents illustrations of the products and their applications. The B. F. Goodrich Co.

MISCELLANEOUS

41 **Tube Expanders**—This 8-page bulletin is completely filled with information on the company's line of tube expanders. It presents illustrations, tables of sizes for each type of expander and tells the uses for which it was specifically designed. A feature of the booklet is a full page table of nominal inside diameters of boiler tubes with OD's from ⅜ to 5 in. and in gauges from 8 to 20. Richard Dudgeon, Inc.

42 **Machinery Mountings Booklet**—Bulletin BU50 gives complete information on this line of machinery mounting which are designed to stop transmission of vibration as well as provide a means of leveling the machines. Dimensioned drawings accompany tables which show prices, load capacity, weights and other data. The booklet is profusely illustrated. Bushings, Inc.

43 **Lifting Device**—"No Teeth But What a Bite" aptly describes this device which is called "Granny-Grip" by its manufacturer. This 4-page catalog tells about this cam-lever mechanism and chain that grabs up heavily laden steel barrels, steel plate, etc. and holds it in a grip that grows tighter as the load grows heavier. The Boyer-Campbell Co.

44 **Hot Spot Indicators and Quenchers**—This 4-page bulletin tells about the company's hot spot indicators for warning of dangerous hot spots in coal piles and also about the Quenchers—devices which utilize dry ice to give off carbon dioxide gas which puts out the fires without bulldozing or moving the coal piles. Both the devices are illustrated and their uses explained. It points out how the indicators give warning of danger spots three days in advance of the time the kindling point will be reached. Coal Specialties Co.

45 **Unit Heaters, Blowers, Fans**—Here is a condensed catalog of the products manufactured by this firm. It is a six-page bulletin and contains thumbnail descriptions and illustrations of unit heaters, heater sections, blowers, draft inducers and fans—each of these classifications has several types of products. The history of the company is given on the last page of the folder. L. J. Wing Mfg. Co.

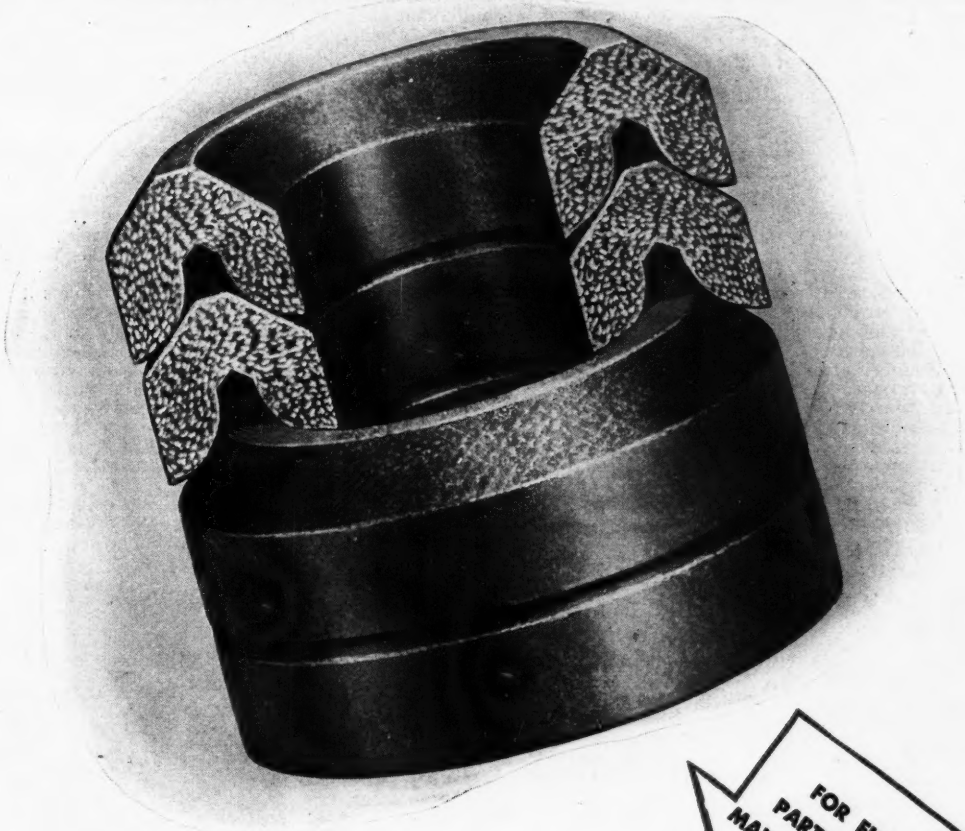
46 **Gas Scrubbers and Coolers**—This four-page Bulletin H-202 has just been issued. It deals with the company's gas scrubbers and coolers. An explanation of how the scrubbers serve industry is the introduction to the bulletin and line drawings and photos are used to illustrate the points brought out. A complete description of the unit is included in the material which follows. The Peabody Engineering Corp.

47 **On-the-Job-With-Oil**—Case histories of this oil in action in industry is the

(Continued on page 170)

PALMETTO *Pyramid*

THE MOST TALKED ABOUT IMPROVEMENT IN MOLDED "VEE" PACKINGS



Engineers everywhere are talking about the newest addition to the PALMETTO family. PALMETTO Pyramid, a new design principle in all-purpose molded "Vee" type packings, seals completely with simple finger-tightening . . . and is *entirely automatic* in performance. A unique "arrowhead reservoir" stores and distributes lubricant. The result is reduced friction and less wear and that means longer packing life and longer equipment life.

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Plants at New York, N. Y. and North Wales, Pa.

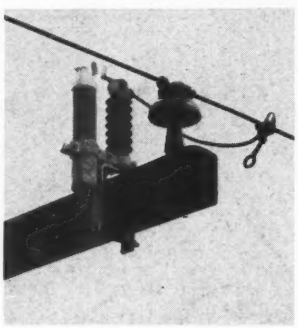
New Equipment News

The new equipment items in this section are identified by letters which precede the headings. When further information is desired regarding any of this equipment write this corresponding letter on the coupon in the Helpful Bulletins section, cut it out and send it to Power Plant Engineering, 53 West Jackson Blvd., Chicago 4, Ill.

A Lightning Arrester for Rural Lines. The Hi-Stroke Rural Arrester, a new heavy-duty expulsion-type arrester for lightning protection on rural lines has been announced by the Transformer Division of the General Electric Company. The new arrester is designed specifically for rural systems and is available in 6- and 9-kv ratings.

A unique feature of this arrester is the location of the internal gap in an interrupting chamber which contains gas-evolving material in the form of cellulose fiber spheres. A reserve column of spheres located above the interrupting chamber compensates for power-current erosion by replenishing the supply of the spheres in the arc interrupting chamber after each discharge of the arrester.

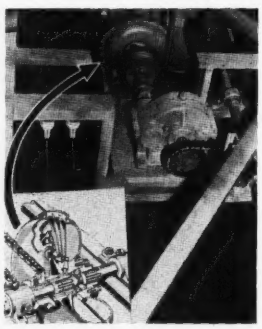
Leakage current through the arrester is impossible as the line terminal and line side of the external series gap is supported by an insulator entirely separate from the



arrester element. The separate insulator assures that no voltage is applied to the arrester element except during actual discharge, and also eliminates any possibility of line lockouts as the line lead to the arrester remains supported and cannot dangle in contact with the other conductors or ground in event of failure of the arrester element.

B Fluid Drive Coupling. A fluid drive coupling that is proving itself in an amazingly varied number of applications is now in production by the Toolcraft Manufacturing Co.

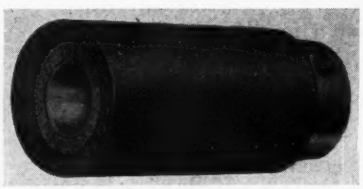
This hydraulic oil coupling eliminates the necessity for both a transmission and differential mechanism. The principle of operation is simple—the unit being self-contained and consisting of three basic parts. It can be installed directly on the shaft of any engine or electric motor—it engages and disengages without human control and slippage is eliminated. In general industry it has an amazingly wide variety of uses—for cranes, refrigeration units, hoists, winches, conveyor



systems, packaging machines, and wherever smooth starting and stopping of power-driven equipment is necessary. Because this fluid drive coupling is completely enclosed it prevents the entrance of dirt and dust which causes ordinary clutches to grab and jerk.

C New Coupling. A new coupling for oil burners and air conditioning units, also applicable to many other machines requiring maximum flexibility, has been developed by the Lovejoy Flexible Coupling Co. CX Double-flex cannot fall off when driving and driven units—as for example, an oil burner blower fan and motor—are separated for servicing.

This new coupling embodies the most notable improvements in couplings for this particular purpose. It is remarkably compact, easy to in-



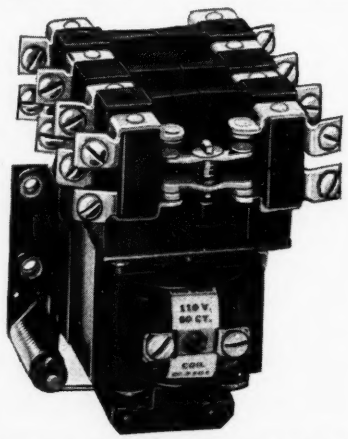
stall, and it insures new coupling dependability.

Of one-unit construction, this coupling comes out with the shaft when pump or motor is moved. A standard L-R body is permanently inserted into the molded synthetic rubber unit, this being permanently secured to the pump shaft by a set-screw. Molded into the other end are the L-R sockets that engage L-R jaws on the blower hub.

Other advantages of the Type CX Double-flex are: Quick assembly in dark or close quarters, no metal to metal contact, tight fit — no rattle, deeper center hole allowing shaft to extend ⅛ in. into unit. Six sizes from 2¼ in. to 5 in. long.

D Universal Solenoid Relay. Unusual flexibility is the outstanding feature of a new line of universal type solenoid relays recently developed. In these relays, which are an addition to the regular Bulletin 700 line of solenoid relays, a simple shift of connections makes it possible to change a set of normally open contacts to normally closed operation, or vice versa. Thus, the equipment designer can provide for future changes with a minimum number of components. It was developed by Allen-Bradley Co.

Bulletin 700 Universal Solenoid Relays are available in 2, 4, 6, and 8-pole construction. All the contacts on the 2-pole and 4-pole relays are of the universal type. The 6 and 8-pole relays have only four sets of universal

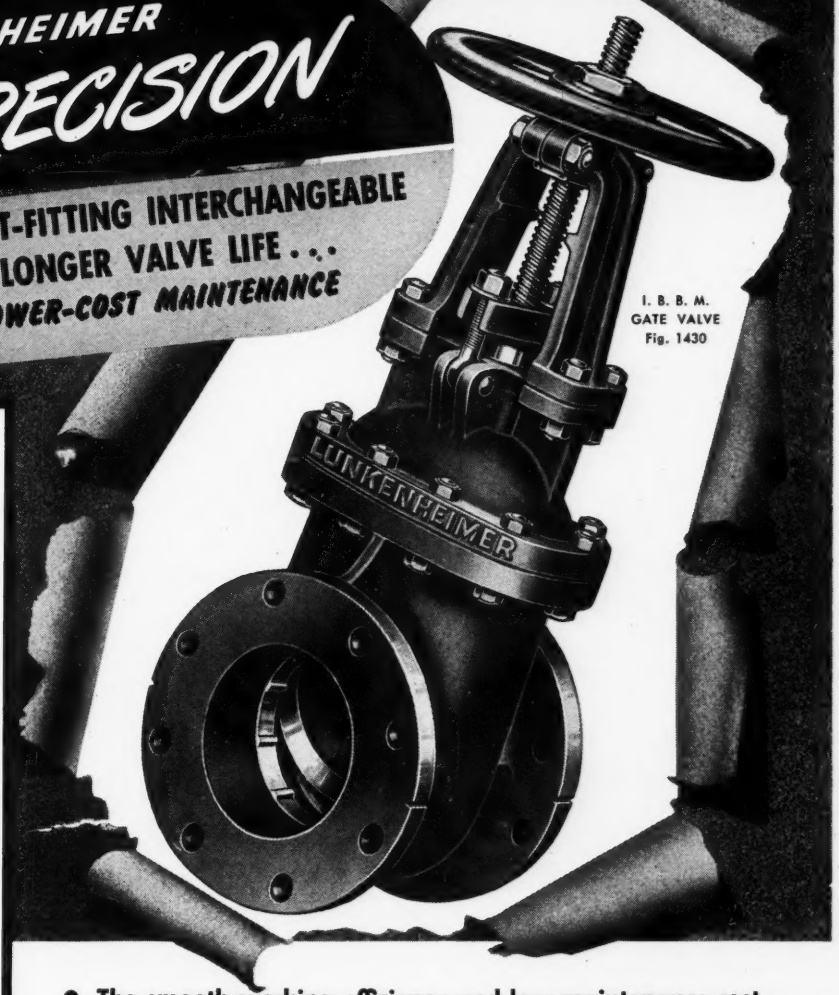


contacts. The remaining contacts are of the conventional, normally open or normally closed type which cannot be changed in the field. These relays have a maximum current rating of 10 amp, noninductive, and can be obtained for operation on 25, 30, 40, 50, and 60 cycles with voltages of 6, 12, 24, 32, 64, 110, 220, 440, 550, and 600. The universal type should only be used for switching circuits of like polarity and cannot be used as reversing switches.

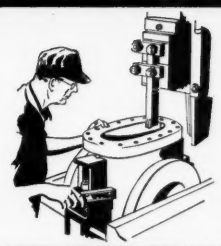
These relays can be obtained either in the open style or mounted in an enclosure. Three enclosures are available: the standard, general purpose

LUNKENHEIMER PRECISION

ASSURES PERFECT-FITTING INTERCHANGEABLE PARTS . . . LONGER VALVE LIFE . . . EASIER, LOWER-COST MAINTENANCE

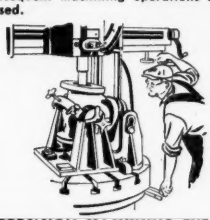


I. B. B. M.
GATE VALVE
Fig. 1430



HE GIVES LUNKENHEIMER VALVES SOMETHING OTHER VALVES HAVEN'T GOT

He machines body guides down to precision tolerances, assuring a perfect guide for the disc and creating a positive center line on which all subsequent machining operations are based.



PRECISION MACHINING THE BODY FOR SEAT RINGS

is precision work to the "nth" degree, for this operation makes inserting the seat rings in a Lunkenheimer gate valve simply a matter of screwing them into position. Parts can be replaced without any machine work or special fitting.

- **The smooth-working efficiency and low maintenance cost of Lunkenheimer Valves were not "made in a day". Behind this superior performance and economy lies long experience, and an ideal of precision which guides every operation from design to final assembly.**

Lunkenheimer Valves have a streamlined simplicity of design . . . a minimum of working parts, each part of extra strength, correctly proportioned and perfectly balanced. This assures longer life with the least trouble and maintenance expense.

A Lunkenheimer Distributor is located near you, equipped and ready at all times to help you solve problems of maintenance or operation.

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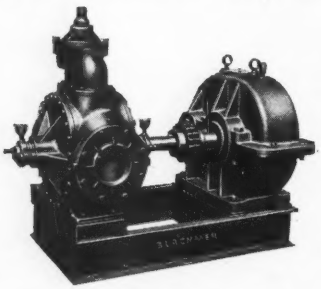
Bronze, Iron, Steel and Corrosion Resistant Alloy Valves, 125 to 2500 Lb. S.P.; Boiler Mountings, Lubricating Devices, Aircraft Fittings

LUNKENHEIMER VALVES

NEMA Type 1, sheet steel enclosure; the watertight and weatherproof NEMA Type 4, cadmium plated cast-iron enclosure; and the cast-iron NEMA Type 7 enclosure for use in hazardous gas locations.

In general, the construction of the Universal Relay follows that of the regular Bulletin 700 line. Double break, silver alloy contacts are used which do not require any attention such as cleaning, filing, or dressing. Oxides which may form on the contacts are good electrical conductors. No pins, pivots, hinges, or bearings can be found in the mechanism because of the simple, up and down solenoid action. Only one moving part is used, eliminating the sticking and binding prevalent in mechanisms with many moving parts.

E Pump for Marine Service. A new, heavy-duty pumping unit with integrally-mounted reduction gear drive has been put into production at the Blackmer Pump Co. The new pump is designed on the swinging vane ("bucket design") principle, which makes it self-adjusting for wear. It has a capacity of 750 gpm at 150 psi discharge pressure and operates at 225 rpm. The internal construction is bronze-fitted, and units are furnished with either anti-



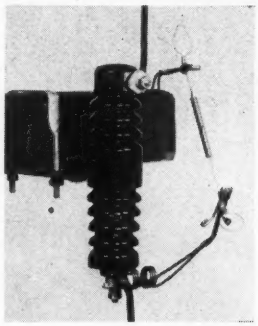
friction or sleeve bearings. The base is structural steel and provides for pump and reduction drive unit only. The prime mover, either engine or electric motor, is mounted separately. A number of the new units are being furnished for pumping fuel oil and lube oil on cargo vessels.

Present plans call for the production of units of similar design with speed variations from 150 to 400 rpm and capacities of 200, 300 and 400 gpm with pressures from 50 to 150 psi for general industrial as well as marine use. Provision will be made for mounting the prime mover on the common base.

F Flip-Open Fuse Cutout. An improved design of the flip-open fuse cutout embodying "bird-proof" construction in 50-amp, 7500- and 15000-v ratings, has been announced by the Transformer Division of the General Electric Co.

These new cutouts have a solid, streamlined, porcelain insulator with the mounting support and the upper and lower contact supports cemented into the porcelain so that the live parts are confined to the side of the insulator opposite the mounting bracket. The cutout may be mounted vertical, angle tilted, or swiveled to any desired position; either in separate mounting, or in combination cross-arm mounting or T-bracket pole mounting with G-E Pellet type arrester or Hi-Stroke rural arrester.

The construction provides an inex-

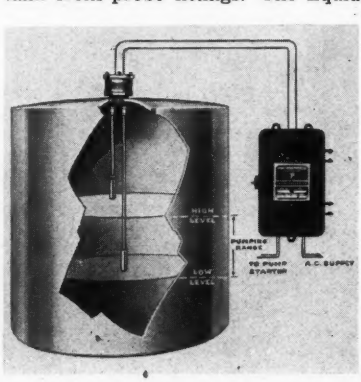


pensive cutout for rural line service where the available short-circuit currents are limited and where the advantage of the hinged fuseholder type of conventional cutout may be dispensable. Bulletin GEA-4224A describes the improved cutout and is available upon request.

G Maintenance-Free Level Control. Photoswitch Level Control, Series 10 makes available to the chemical, sanitary, sewage, and refrigeration fields a series of rugged maintenance-free relays for the level control of all electrically conductive liquids. Contact with the liquid is made only by a stainless steel probe rod (there are no floats, bellows seals, or stuffing boxes). With A. C. in the probe circuit, no electrolytic action is possible. Mica insulated probes insure against leakage.

The level control is recommended for the control of: water, ammonium chloride, copper nitrate, sulphate, sodium chloride, potassium, hydroxide, and many other acids, bases, and salts. Selection from four terminals on the terminal block enables the control to be matched to the specific resistivity of a material.

The operation of the level control is described as follows: stainless steel probe rods are suspended into the tank from probe fittings. The liquid

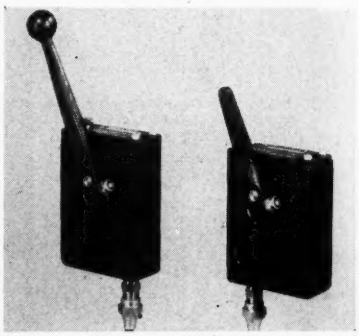


to be controlled makes or breaks contact with the probe and transmits to the control a minute electrical current at low voltage. Without the use of vacuum tubes, this current controls a power circuit which operates a relay to actuate signals, valves, or pumps.

Specifications—Supply: 115 or 230, 50/60 cycles a.c.; total power consumption ½ watt. Output: Single pole, double-throw relay. Contacts: Designed for motor starter, motorized, or solenoid valve operation. Arc suppression is supplied on both contacts for increased contact life. Probe Circuit: Will carry a resistance as high as 3500 ohms.

H Miniature Hydraulic Control. An almost miniature hydraulic remote control, the smallest of its type and weight yet offered to the industrial market, has been developed by Sperry Products, Inc. Numerous applications are possible, but those most frequent are throttle, mixture, governor, and all sorts of position indicator controls.

This new product retains all the advantages of the previous larger units in that only a single flexible copper tube is used, the system is completely enclosed, and the installation is easily accomplished with but three small bolts for each of the two pieces which make up the complete unit.



Transmitter and receiver, made of bronze, together weigh only 3.7 pounds. Any motion of the transmitter arm will be duplicated by the receiver arm. Either arm will move through an arc of 60 deg., and the receiver arm may be drilled at any location to obtain the desired linear travel of the actuating rod.

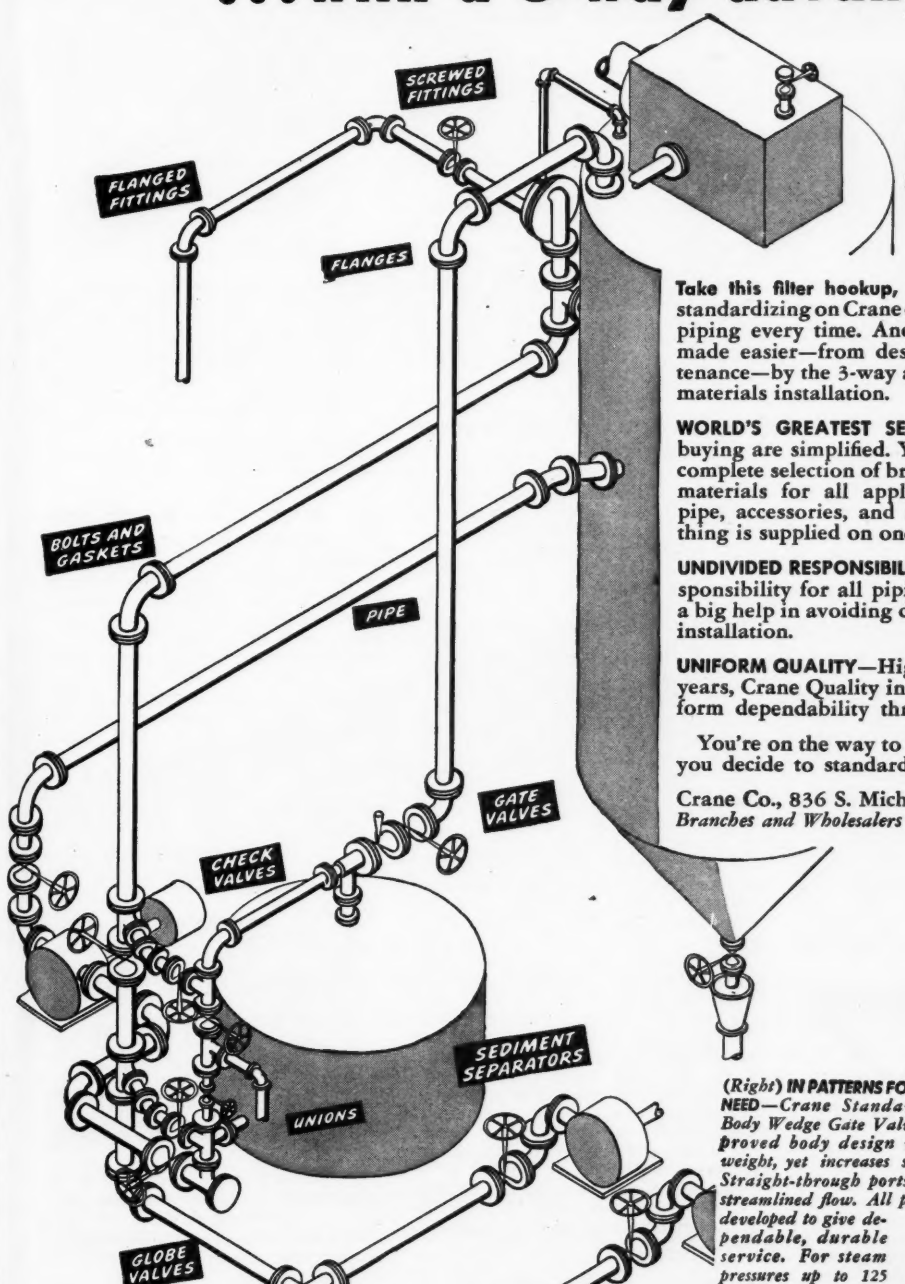
The complete system is dust-proof and water-proof. Transmitter and receiver may be joined by as much as 35 ft. of connecting tubing without experiencing any difficulty, and lengths even longer than that may be used where conditions of temperature and load will warrant it.

J Thermo-Control Fan. A front operating adapter design of the thermal power element in this Thermo-Control Fan has been announced by Thermo-Aire Div. of Evans Products Co.

This new model has been engineered to simplify installation of the Thermo-Control Fan in existing engine mounts when necessary clearances are available. To install the new model, it is only necessary to remove the old fan from the fan hub and remount the Thermo-Control Fan with the correct mounting flange to fit the hub.

The Thermo-Control Fan is a variable pitch self-adjusting fan operated by a built-in thermal power element. Adjusting itself to changes in engine

The ONE way to better piping ...with a 3-way advantage



ONE

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RESPONSIBILITY
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Take this filter hookup, for example, to see how standardizing on Crane equipment results in better piping every time. And how any piping job is made easier—from design to erection to maintenance—by the 3-way advantage of an all-Crane materials installation.

WORLD'S GREATEST SELECTION—Specifying and buying are simplified. You choose from the most complete selection of brass, iron, and steel piping materials for all applications. Valves, fittings, pipe, accessories, and fabricated piping—everything is supplied on one order to Crane.

UNDIVIDED RESPONSIBILITY—You put complete responsibility for all piping materials on Crane—a big help in avoiding delays and getting the best installation.

UNIFORM QUALITY—Highly respected through 90 years, Crane Quality in all materials assures uniform dependability throughout piping systems.

You're on the way to better piping the moment you decide to standardize on Crane equipment.

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Branches and Wholesalers Serving All Industrial Areas

(*Right*) **IN PATTERNS FOR EVERY NEED**—*Crane Standard Iron Body Wedge Gate Valves. Improved body design reduces weight, yet increases strength. Straight-through ports assure streamlined flow. All parts developed to give dependable, durable service. For steam pressures up to 125 pounds; 200 pounds cold. See your Crane Catalog, pp. 101-106.*

EVERYTHING FROM . . .

VALVES • FITTINGS
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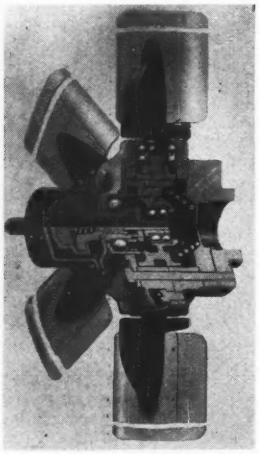
FOR EVERY PIPING SYSTEM

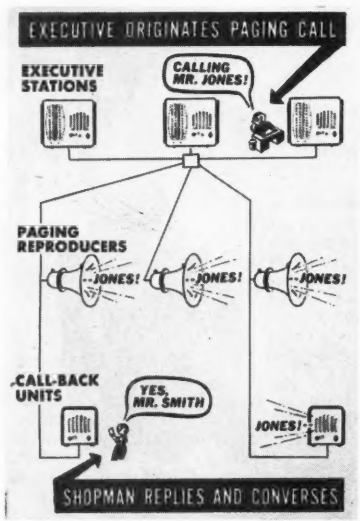
and ambient temperature, the fan maintains near constant engine operating temperature, increasing horsepower output, reducing fuel, lubricating oil and maintenance costs and eliminating nearly all formation of sludge deposits in engine and lubri-



cating oil. The fan is manufactured in four, six and eight blade models.

The fan is designed for installation on such heavy-duty equipment as generators, pumping units, shovels, tractors and cranes, and mobile and stationary industrial equipment.

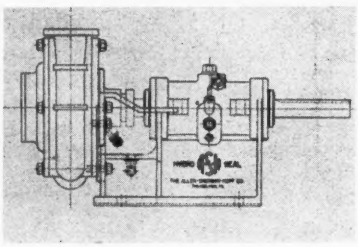
K Call-Back Unit for Intercom. Executone Inc's. new Model C-18 is a combined call-back and sound reproducer unit designed especially for use with high noise level coverage industrial communication systems. It is used with combination intercom and amplified voice-paging systems having any number of fully intercommunicating master stations, trumpet speakers, and other standard reproducers. This call-back unit doubles the efficiency of the intercom-paging system by reproducing the paging call clearly and distinctly and by permitting the person called to reply and converse directly with the executive originating the call.



In actual operation, any executive, receptionist, or telephone operator having an intercom master station on his desk can originate a paging call in addition to having regular two-way intercommunication with all other master stations. To page, he depresses the paging button on his master station and calls by name the person he wishes to locate and speak to. The amplified paging call is reproduced by trumpet speakers and C-18 units which give complete high fidelity voice coverage of the entire office, plant, or factory area.

On hearing his name called, the person paged approaches a conveniently located call-back reproducer station, depresses the key and automatically is connected directly to the executive who originated the paging call. All other amplified reproducers and call-back units are automatically silenced while the two-way conversation is in progress.

L Improved Hydroseal Pump. Recent improvements in Allen-Sherman-Hoff's new Hydroseal abrasive materials handling pump include: New Bearings—Heavy duty, anti-friction radial and thrust bearings are now standard on these pumps. Bearings are interchangeable, New Axial Adjustment—The pump is



now provided with a new, improved means for easy, two-way axial adjustment of the shaft and bearing assembly.

New Pump Shell—No rigid mounting of pump shell or engine side bell to pump base. Both are now supported from the bearing housing. This permits pump discharge to be placed at any of the three positions indicated above. In many cases, this will simplify installation of discharge piping; further, it eliminates "special pump" construction to obtain this result. The inside construction of the pump itself is unchanged.

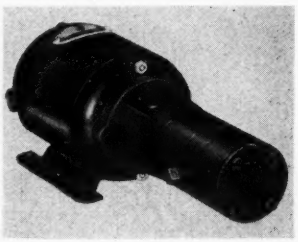
Blueprints of this improved Hydroseal pump will be sent on request, until new catalog, now in preparation, is completed.

M Vane - Type Pump. A new positive pressure vane-type pump, VW-1, designed for handling non-lubricating liquids such as water has been announced by the Eastern Engineering Co.

Incorporated in the pump are two composition bearings requiring no lubrication beyond that furnished by the liquid being pumped. The vanes are made of the same material as the bearing.

By means of a special design of the vanes and by applying the proper radii on the vane edges, the vanes are held in contact with the pump chamber. No centrifugal force, consequently, is required to maintain volumetric efficiency.

The pump is specifically designed for use in systems having a relief



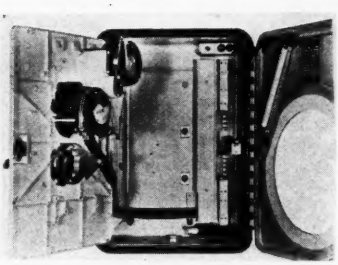
valve and therefore has no bypass valve built into the pump design. Shaft sealing is accomplished by means of a mechanical rotary seal.

Delivery approximates one-half gallon per minute. The pump is suitable for operating pressure of from zero to 30 psi and is self-priming.

The motor is 1/15 hp and is available in either 110 v or 220 v.

N Recorder for Solubridge Readings. A means of continuously and permanently recording the electrolytic conductivity of solutions, condensates or water by the solubridge method, is now provided by the Type RP recorder offered by Industrial Instruments, Inc.

The Solubridge Recorder incorporates an a.c. Wheatstone bridge circuit operating on the null balance principle. The accuracy is consequently made independent of line-voltage fluctuations and vacuum-tube characteristics. The instrument can be furnished for 1, 2, 3 or 4 continuous-line records on the same 12-inch diameter circular chart, a separate



amplifier and motor-driven slide wire being used for each recording pen so that no switching devices are necessary. All pens of a multiple-pen recorder may move at any time or simultaneously.

The slidewire unit mounts on the inside of the hinged panel immediately in back of the front door. The amplifier is normally mounted on the rear of the recorder casing. The compact amplifier amplifies the Wheatstone Bridge output voltage and provides the electronic control of the slidewire drive motor both as to direction of rotation and speed. The amplifier is a standard and interchangeable unit.

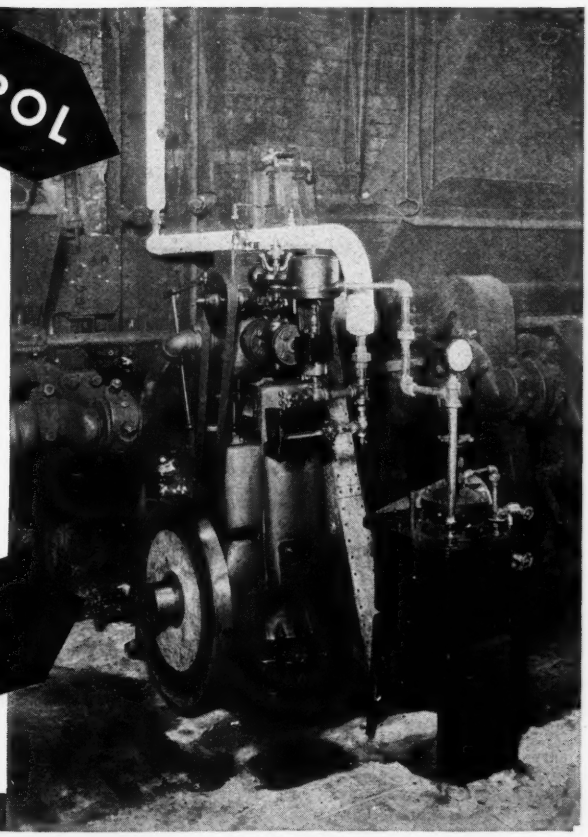
Housed in a sturdy metal cabinet, the instrument shows the circular recording chart through the glass window.

CLOSE SPEED CONTROL

IS THIS WHAT *You* WANT?

WIDE SPEED RANGE

TROY-ENGBERG STEAM ENGINE



The steam engine can idle along or can turn over at top rated speed which is many times the speed of idling or it can be set at any intermediate speed.

This is one reason why you will find Troy Steam Engines on so many stokers, particularly those with widely varying boiler loads. And this same flexibility coupled with close speed control makes the steam engine very useful for driving other equipment which operates with variable speeds. Industry has plenty of such installations... and plenty of use for the modern Steam Engine.

Are you planning to purchase any equipment that requires a drive? Do you have some drives that should be changed? If so, we suggest you investigate the Troy-Engberg Engine.

TROY ENGINE & MACHINE COMPANY
Established 1870
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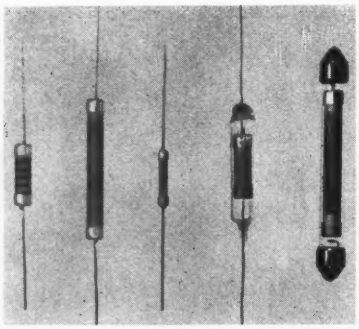
Bulletin No. 306 will give you information on the Troy-Engberg Steam Engine. Shall we send you a copy?

TROY-ENGBERG
STEAM ENGINES • GENERATING SETS • GENERATORS

O Wide Range Film Type Resistor. A new film type of resistor is now available for instrument, radar, and television manufacturers.

The unique characteristic of these resistors lies in the fact that they can



be supplied having 1 per cent accuracy at 100 megohms with temperature, voltage and humidity coefficients being within 0.1 per cent.

This new resistor at present will be available in two sizes: (a) 1 watt —¼ in. diameter × ⅞ in. long, axial leads, having a resistance range of 10 ohms to 35 megohms at 1 per cent accuracy. (b) 2 watt—¼ in. diameter × 2 in. long, axial leads, having a resistance range of 10 ohms to 100 megohms at 1 per cent accuracy.

Equipment is now being constructed to manufacture a small size resistor: ½ watt—⅛ in. diameter × ⅞ in. long having a resistance range of 10 ohms to 15 megohms at 1 per cent accuracy.

It will be possible later to supply these same resistors hermetically sealed in glass attaining 0.15 per cent accuracy. These resistors are being manufactured by Wilkor Products, Inc.

P Rench Aid. A new formula, described by the manufacturer as superior to penetrating oils, for removing aluminum heads, loosening rusty nuts, bolts, pipe threads, locks,

has been announced. There is no offensive odor. It does the job quickly, easily, it is reported. Rench Aid comes in pints, quarts and gallons, in attractive four color lithographed cans. It is manufactured by the Lubaid Co.

Q New Cleaning Agent. An entirely new type of detergent for use in steam cleaning has been developed by The Penetone Co. The new cleaner is a liquid compound, water-soluble.

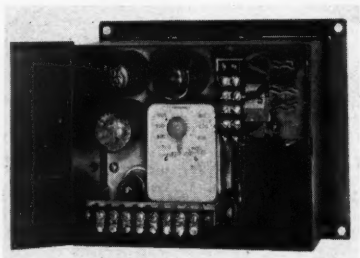
By the use of the new liquid compound, not only is it possible to keep the equipment in constant use, but there is a definite saving in wear and tear on the parts. Indeed, equipment which is already clogged from previous use may be cleaned by operating it with the new liquid.

Nor has any degreasing efficiency been sacrificed to achieve this advantage. The compound has a high alkalinity and will rapidly remove stubborn grease, oil, and grime accumulations from the kind of surfaces and materials on which steam cleaning is employed. In spite of its potency, however, it will not affect paint or other finishes.

Another advantage, important from a time-saving standpoint, is the fact that the solution need not be premixed. The water and cleaner, in correct proportion, are poured right into the equipment tank and the solution is ready—no agitation or waiting is necessary as the product is instantly soluble in water.

R Thermal Protector. Manning, Maxwell & Moore, Inc., announce a new Ashcroft Thermal Protector—a thermocouple-actuated limit switch.

As an example of its use, the manufacturer states that protection is required in air ducts on industrial ovens, dryers, bearings of large motors, blower wheels, flue gas stacks of boilers, plastic injection presses, reheat-



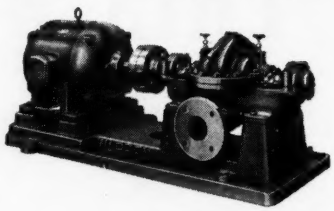
ers, etc. The temperature chosen as the high limit is set by an operating knob located inside the case where it will not be tampered with. If this temperature is reached, the device will stop the apparatus before excessive damage is done, or it can be arranged to sound an alarm or light a light. If desired, either or all of these functions can be performed at the same time.

In addition to protection from excessive temperature, the device will "fail safe" in case of burning off or breaking of thermocouple, failure of power supply, tube or mercury switch. A still further protection is provided by a manual reset. This makes certain that something is done to correct the cause before the equipment is damaged or production is seriously interrupted. This device is truly a "fail safe" switch.

The thermal protector is designed with two ranges, 100 F to 1000 F using an IC couple, and 800 F to 2000 F using an a c couple with an accuracy of 2 percent of the range at a set point. Two or more couples may be connected, in series if desired. The cold junction is located in the unit and is compensated to ambient temperatures of 50 F to 135 F and a relative humidity up to 100 percent.

The current characteristics are 115-230 v 60 cycle a c 15-20 w. There are no open contacts in the device and the circuit for the signal and power input to the apparatus is a standard 4 amp. 250 v mercury switch.

S Centrifugal Pump. Warren Steam Pump Co., Inc., has just announced this single stage, double suction centrifugal pump which is designated as Type DBL. Capacity of the unit is from 50 to 600 gpm on



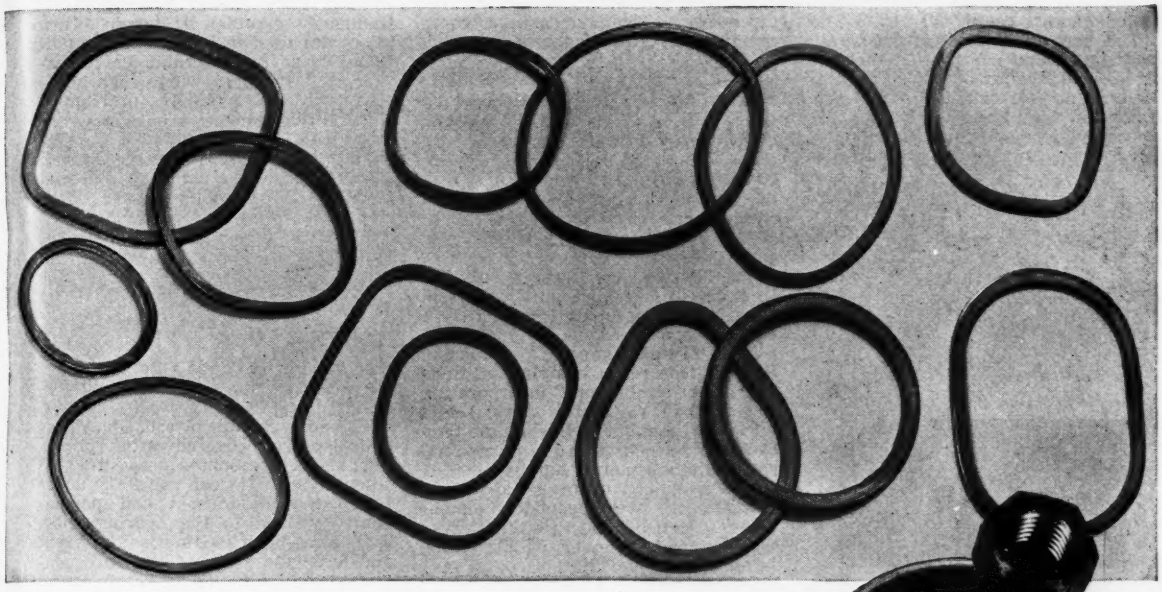
heads from 120 to 260 ft. It operates at 3500 rpm. The pumps are available in 1½, 2, 2½ and 3 in. discharge sizes and with either right or left hand rotation. Bronze-fitted pump is standard but special metals can be furnished for special services.

T Water Repellent Material. Faster starting of fluorescent lamps by the application of G-E Dri-Film, new water repellent material, is being accomplished on a certain type of fluorescent lamp now being made at the G-E factory at Hoboken, New Jersey, it was revealed today. The new material forms an invisible and permanent "rain coat" over the lamp and. when used with metal adjacent to the lamp such as a reflector, makes it practically insensitive to high humidity.

General Electric lighting experts said the Dri-Film is the best material yet found to form a continuous insulating film over glass. It is applied easily and lamps can be maintained with only customary cleaning. Tests have shown that the lamps, when coated with it, operate satisfactorily even under 100 per cent relative humidity.

U Trash Racks and Rakes. New developments in trash racks and rakes have been announced by the Rodney Hunt Machine Co.

The new trash rack has an improved all welded back bar construction. The vertical slats have no holes to weaken them, are spaced exactly to specifications by precise jigs and fixtures, and are welded into position so they cannot bend or twist, the manufacturer says. The racks can be quickly installed in sections by tack welding or clipping and bolting the adjoining back bars for a permanent installation which will not move or vibrate. Heavily covered with a specially developed water-resisting black



AJAX

"INSTALLED ECONOMY"

HIGH and LOW PRESSURE BOILER GASKETS

Boiler "outage" held to minimum! Power, industrial and marine engineers confirm this direct result of installing AJAX Spiral Wound Gaskets in their manhole, handhole, tubecap and other boiler assemblies.

AJAX metal-asbestos boiler gaskets are available in these major pressure ranges — 0 to 499 lbs., 500 to 999 lbs., and 1000 lbs. up. Stainless steel is recommended for pressures over 500 lbs. — however, both construction materials and the number of spiral wound plies per diameter are determined by your particular service requirements or specifications.

AJAX Gaskets are easy to install and remove. They seal securely under a comparatively low bonding pressure, which eliminates excessive strain on fittings. The springback or "breathing" quality of AJAX Gaskets compensates for temperature and pressure fluctuations.

Assurance in service . . . trouble-free installations . . . these are true gasket economies, the economy of AJAX Spiral Wound Metal and Asbestos Gaskets.

Distributors in Principal Cities ★ ★ *A few choice industrial territories are open*

Write today for complete AJAX data—available in Catalog 202

See our catalog in Sweet's — Power and Process Files

U. S. GASKET CO.

610 N. 10th STREET, CAMDEN, NEW JERSEY

High speed production machinery and the quality of U. S. Gasket-engineering assures the consistent accuracy of AJAX Gaskets. Complete listing in Catalog 202.

★ **"THE STORY BEHIND THE GASKET THAT BREATHES"**

Note on this cutaway drawing, the small air space under each U-groove in the metal ply.

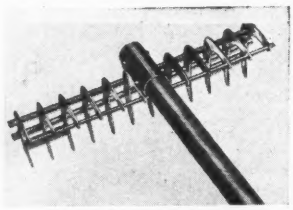
There are twin strips of asbestos filler between each spiral thickness in the AJAX Gasket which cannot meet in the center under the wedge-like groove. Therefore a "breather-space" is preserved in the heart of the gasket which assures its automatic reaction to mechanical compression, to internal pressure variation, and to temperature changes.

The AJAX Gasket expands and contracts — "breathes" — with changing pressure conditions — and retains the positive, secure seal you require at all times.

The above cutaway is the AJAX SR Compression Gauge Flange Gasket

asphaltum paint, the rack is protected against corrosion.

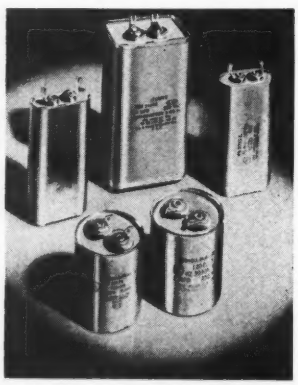
The new stainless steel trash rake is designed and constructed to be as strong and rigid as one piece of steel. Made to precise specifications of noncorrosive "life time" stainless steel. Specially formed basket-type teeth offer great capacity and the ultimate



in strength and rigidity. The teeth are spaced to engage the slats of the trash rack correctly, and double length guards prevent interference between the teeth and the back bar of the trash rack. This rake head, combined with the tubular handle provides a buoyancy "air chamber" and lightness to the rake. It is tough, strong, resilient and not effected by moisture. Because of a revolutionary self-lifting feature, it requires only a small pull to bring the buoyant rake to the top of the rack for easy unloading, thus saving time and effort on the part of the operator.

V Fluorescent Lamp Capacitors. Cornell - Dubilier Electric Corp. announces a new line of fluorescent lamp capacitors known as types KS, KY and KZ.

Features include: stable operation at ambient temperatures up to 70 C; capacitor terminal construction de-



signed so that capacitor seal remains unaffected after soldering operation; low operating temperature; hermetic sealing; all UL approval; low power factor, 0.25-0.4%; Dykanol impregnation; dual capacity combinations for cold cathode applications; unusual compactness for relative capacity and voltage rating; long forked solder lugs which permit simple and efficient production assembly operations, i.e. dip soldering; small solder lugs where minimum overall length is essential.

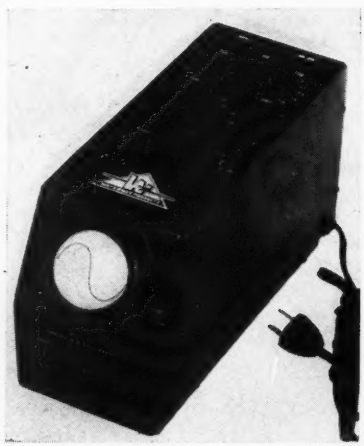
W Pocket-Size Oscilloscope. A new post-war developed lightweight oscilloscope, the "Pocketscope," which embodies all the functions of the conventional instrument but is so compact it can be used in almost any position and is easily carried by hand, has been unveiled by Waterman Products Co., Inc.

The "Pocketscope" weighs only 5½ lb is 6⅜ in. high, 3¾ in. wide, 10 in. deep, and it occupies less than 0.15 cu ft of space.

The "Pocketscope," or model S-10-A, features a complete cathode ray tube oscilloscope incorporating the cathode ray tube, vertical and horizontal amplifiers, linear time base oscillator, synchronization means and self-contained power supply.

The new instrument is capable of indicating in two independent dimensions — vertical and horizontal. As used normally, the vertical dimension is amplitude, and the horizontal may be either time or amplitude.

Although it has practically unlimited application, some of its common



uses include study of wave shapes—measurements of modulation, frequency, phase shift, voltages, power, distortion.

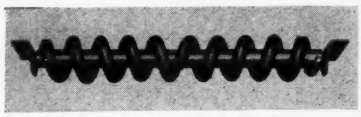
The "Pocketscope" cathode ray tube is magnetically shielded and the telescoping light shield (1¼-in.) permits observation even in places of high light intensity. The angle vision is great. The construction of the "Pocketscope" permits its physical use on the floor, on the bench, or in any position convenient to the operator without diminishing the wide angle of vision.

The controls and terminals are placed functionally so as to permit easy adjustments without reference to complicated instructions. No reconnections are required for signals passing either through the amplifier or directly to the reflecting plates.

X Spiral Return Idler. Chain Belt Co. announces the manufacture of a new belt conveyor idler to be known as the Rex Roller-Bearing Style No. 55RC Rubber Covered Spiral Return Idler.

This special idler was designed to combat many of the common faults frequently experienced when return idlers are used under extreme conditions where freezing and ice formation on the rolls or where high abrasive wear on the roll is a problem.

Since the carrying side of the conveyor belt directly contacts the face of the return idler, the return roll is subjected to the action of material adhering to the belt surface. With

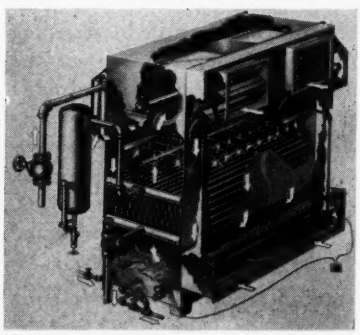


this thought in mind, the design of the new idler can better be understood.

This idler is built of a flat-bar steel helical spiral, covered with rubber. This spiral is mounted on a standard assembly. The steel spiral is accurately machine-formed and permanently welded to the bearing tube. The spiral itself is composed of right and left hand sections to insure centering the belt. Thus, there is no tendency for the belt to laterally drift to one side or the other.

Y Aero-Pass Condenser. The Niagara Blower Co. announces the introduction of the Aero-Pass condenser for the condensing of refrigerant gases with automatic year-around operation. The purpose of the equipment is to obtain the most economical operation of refrigeration machinery by constantly producing, under automatic control, the lowest practicable head pressures at the compressor.

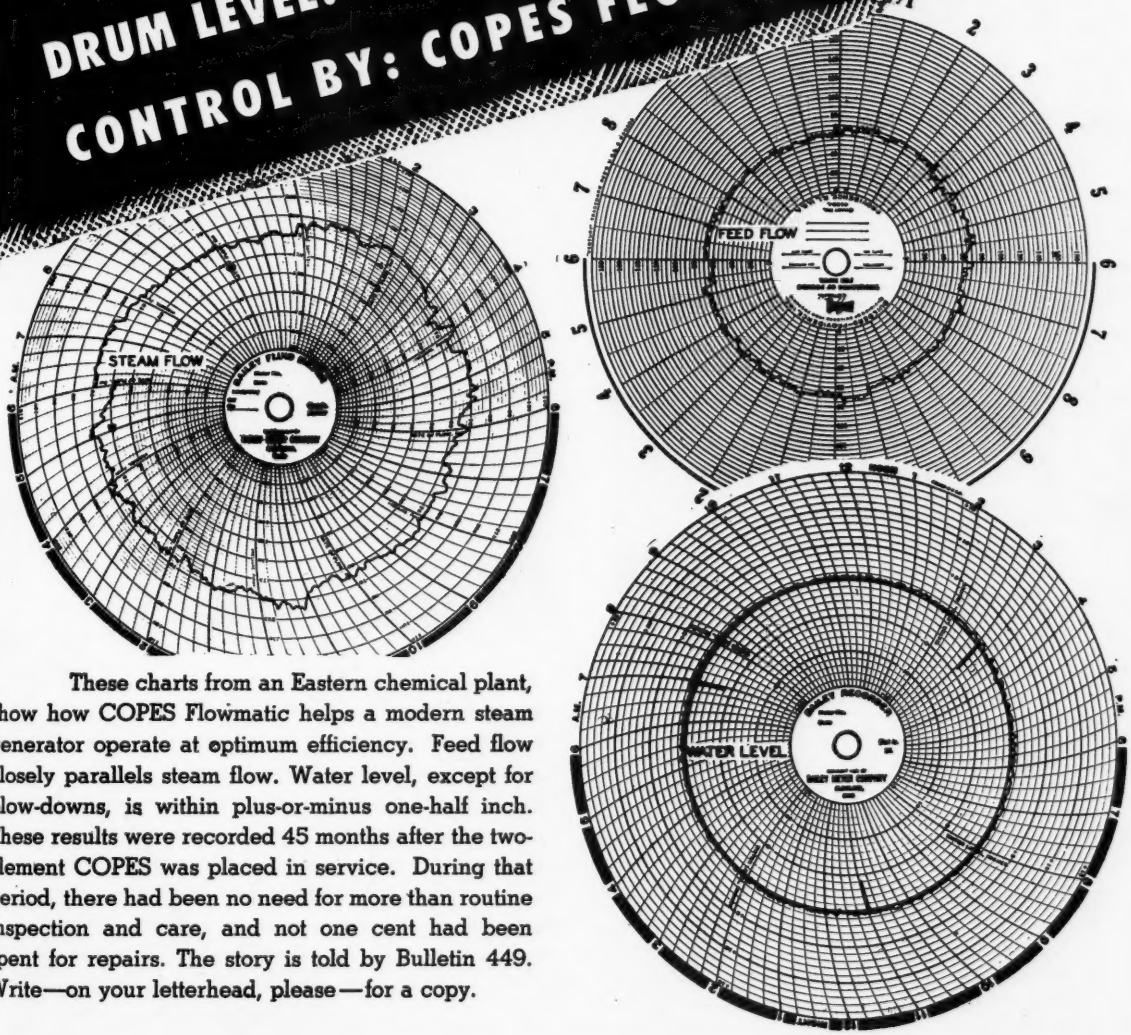
The apparatus consists of two condensing coils, the first of which is a dry coil in which the temperature of the gas is reduced close to the point of condensation. The second coil is sprayed with water, which, as it is evaporated in a fan-induced air stream, reduces the gas temperature by 1000 Btu per lb of water evaporated and



causes the condensing of the refrigerant. The water is recirculated and only the amount evaporated is consumed.

To this is added the Balanced Wet Bulb Control. Through a recirculating duct a varying amount of the air stream is diverted under automatic control as is necessary to obtain always full condensing capacity to hold the minimum head pressure required for the proper distribution of the refrigerant through its system.

THE BOILER: Foster Wheeler Type S.A.
DRUM LEVEL: Plus-or-Minus ½ inch
CONTROL BY: COPES FLOWMATIC



These charts from an Eastern chemical plant, show how COPES Flowmatic helps a modern steam generator operate at optimum efficiency. Feed flow closely parallels steam flow. Water level, except for blow-downs, is within plus-or-minus one-half inch. These results were recorded 45 months after the two-element COPES was placed in service. During that period, there had been no need for more than routine inspection and care, and not one cent had been spent for repairs. The story is told by Bulletin 449. Write—on your letterhead, please—for a copy.

NORTHERN EQUIPMENT COMPANY, 962 GROVE DRIVE, ERIE 6, PENNSYLVANIA

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

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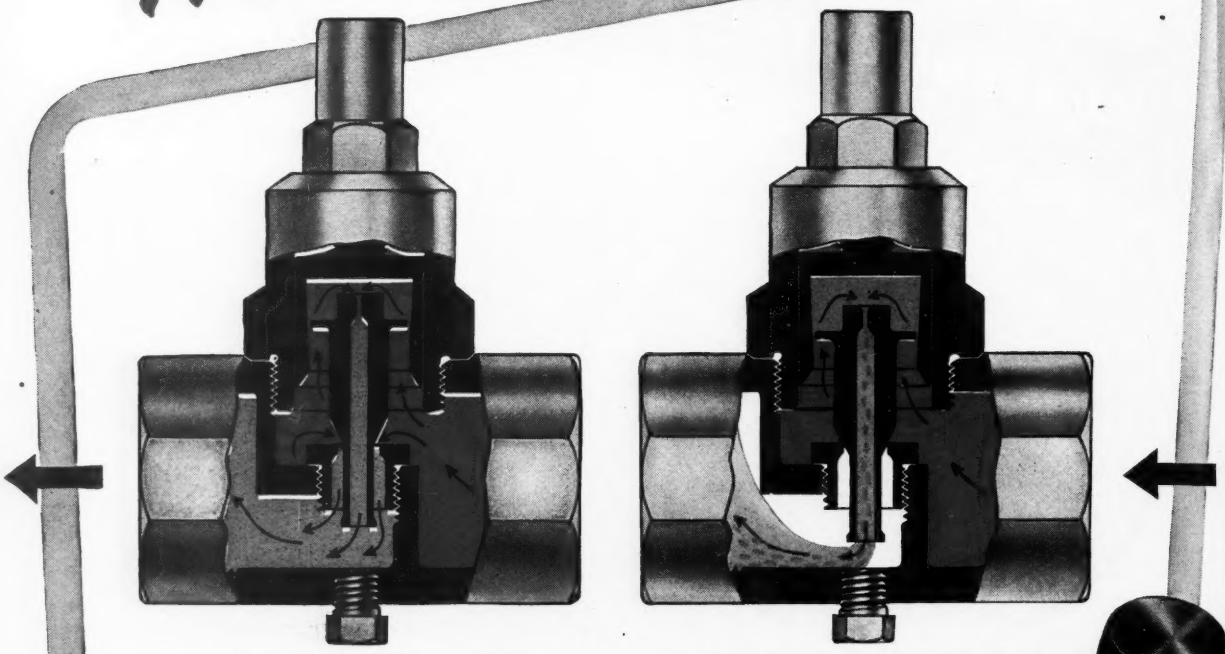
WHY YARWAYS GET EQUIPMENT

Hotter, Sooner



VALVE OPEN—Main flow through seat.

VALVE CLOSED—Main flow shut off.

There's a basic reason why the Yarway Impulse Steam Trap gets equipment hotter, sooner . . . and *keeps it hot.* It's this . . . As soon as steam is turned on, the Yarway trap opens wide and discharges air and condensate continuously until the system is cleared. Equipment is brought to working temperature in the shortest possible time.

Once working temperature is reached, Yarways discharge intermittently to *keep* equipment at peak performance. Under very light condensate loads, discharge is small and continuous through control orifice, and main valve does not lift. *There is no wasteful steam leak,* since a mere 3% of full condensate capacity keeps control orifice completely sealed against discharge of live steam.

No wonder more than 450,000 Yarways have already been sold. They not only speed production . . . but also produce substantial operating economies.

Other Yarway advantages—*small size, easy maintenance, low price.* For full description and operating details of the Yarway Impulse Steam Trap write for Bulletin T-1739.

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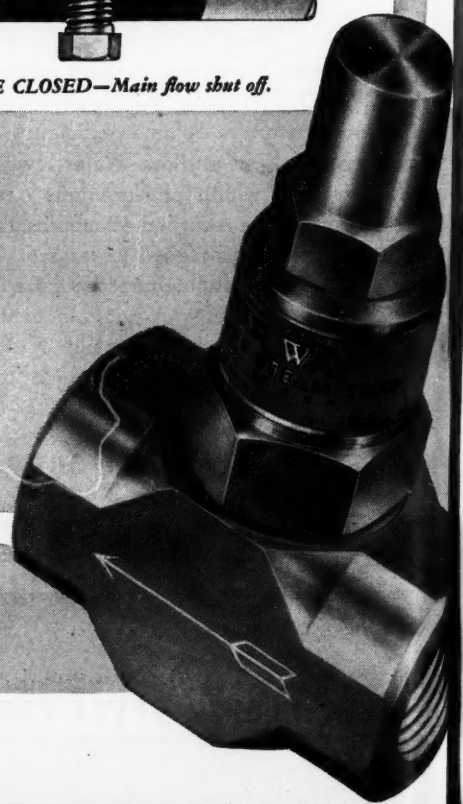


YARNALL-WARING COMPANY, 114 Mermaid Ave., Phila. 18, Pa.

Yarway Impulse Steam Traps are now made and sold in Canada and Great Britain

YARWAY IMPULSE STEAM TRAP

Is Science's Waterloo at the Library?

By **CHARLES R. HAMMOND**

Much has been said about the atomic bomb. With it has come a new era called the "atomic age" with many extravagant predictions as to future scientific discovery and development. But more important, it has made us suddenly realize the magnitude of the advancement made in science and technology in the past two decades as compared to previous centuries. What has brought about this astounding acceleration in science during the past twenty years, the like of which the world never before has seen? Do the people of our planet now have better learning capacities, or is the quality of our mental equipment so far superior to that of our forebears that we now are capable of understanding where before we could not? This does not seem likely. The advancement is due to something else—from education that has come through the diffusion of scientific and technical knowledge.

Discoveries in science are made in two ways. One method starts from scratch and uses trial and error learning, experimentation, and straight mental work; the other begins by reading what others have done, profits by their discoveries and errors, and applies original thinking during new experiments or in formulating new ideas suggested by reading. There can be no doubt that the latter method is more desirable, as it is by far the more economical both in time and money. If we are to use the more economical method in scientific discovery, it is evident that adequate library facilities are extremely important.

Scientists are very conscientious when it comes to publishing their findings and winning recognition for themselves. In general, the rewards of science are not as lucrative as those of many other professions, and recognition is often the sole reward for many months or even years of hard work. As a result scientists write voluminously. It is not generally appreciated that in the field of physics, chemistry, medicine, agriculture and technology, there are more than 30,000 different scientific and technical journals published either monthly or quarterly, to say nothing of other publications such as reports, memoranda, books, and pamphlets.

Are our present library facilities adequate to handle this volume? And what is meant by being adequate? If we expect our libraries to exist solely for storing data, as a warehouse is used for storing bales of cotton, then our present day libraries are doing a cracker-jack job and are adequate. On the other hand, **if we intend that our libraries be not only depositories of information, but also be responsible for correlating these data and information in such a fashion that the material can again be found without long and tedious search, then our present libraries have failed and failed badly.** Undoubtedly many librarians will take issue on this point, contending that a fairly complete analysis or correlation of information is not their responsibility. Perhaps they are right, but whose problem is it if it is not the librarian's?

How technical information is lost in a library, because of inadequate analysis and correlation of data, may easily be shown. For example, consider Strong and Neher's book entitled, *Procedures in Experimental Physics.* This text contains an excellent treatment of the subject of glassblowing, aluminizing mirrors, sealing vacuum systems, and sensitizing photographic plates to ultraviolet light. One of the nation's finest libraries catalogs this book under the heading, "Physics—Laboratory manuals."

Now, the poor scientist will go to the library catalog and want to find something about glassblowing, and what happens? He will find no entry under glassblowing referring to Strong's book; instead he probably will find a few books, most of which are completely obsolete, and perhaps one that gives him a rough idea of what he is after—nothing to be compared with Strong's. **The time has come when classifying a book or document under a general subject heading such as "Physics — Laboratory manuals" is as grave an omission as filing it under "Miscellaneous."**

It must be realized that a library such as the Library of Congress has so many books on physics alone, that if they were stacked on top of one another it would require a ladder 2,000 feet high to reach the top book. And the Library of Congress does not have, by any manner of means, a complete file on physics publications. The Naval Ordnance Laboratory could easily add 300 feet to its voluminous collection without duplication. Just exactly what is happening to our scientific literature is not clear, but it is apparent that because of inadequate analysis of data in our libraries, we have already lost many valuable ideas and concepts, and we are duplicating effort at an unprecedented rate. It will be im-

(Continued on page 85)

From the April 1946 issue of *report*, a monthly publication of the Naval Ordnance Laboratory.

Charles R. Hammond, Librarian of the Naval Ordnance Laboratory, Washington, D. C., born in Fulton County, Illinois, in 1915, was graduated in 1938 with an A.B. degree from the University of California at Los Angeles. He majored in astronomy with specialty in Binary stars, astrophysics, and meteorites. He was teaching assistant in astronomy, 1936-1938. Co-director of the La Crescenta (California) Observatory 1937-1940. He studied the Milky-Way System and compiled astrographic charts from +90 degrees to —40 degrees declination, photographed and published several articles in eclipses and unusual meteors. He was associated with Ellis Klatscher and Co., Los Angeles wholesale merchandising firm, in 1939. From 1940-1942 he assisted in the educational training program for Lockheed and Vega Aircraft Corporations and became Librarian of Vega Aircraft in 1941. He was appointed Librarian of the NOL in 1942 and holds that position at the present time. He is a member of the Royal Astronomical Society of Canada, Society for Research on Meteorites, Société Astronomique de France, Charter member of the NOL Technical Reserve, Special Libraries Association, and other societies, cooperating member, Central Navy Indexing Panel.

6 Years at 600 Pounds at G. E.

By **L. R. BIGGS** Construction and Engineering Division, General Electric Co.

THE RUMBLINGS of war are slowly passing and many industrial plants are again looking toward the future with the intention of replacing equipment so that power and steam can be produced at the lowest possible cost. It is with the thought that the experience obtained from an industrial power plant operating at 600 lb pressure and 825 F over the past six years may be of interest and value that the following is presented.

In 1937 in one of our power plants it became apparent that something would have to be done because of over-age of equipment. The plant consisted of twelve 500-hp boilers operating at 190 lb pressure, one 1500-kw vertical turbine-generator, and one 3000 and one 2500-kw condensing extraction turbine.

The heat balance diagram of the station was rather simple as shown in Fig. 1, and the amount of by-product power generated was small due to the low initial steam pressure.

The steam demand from the factory was such that all of the boilers were required during about eight months of the year. This left the period from June to October as the only available time to remove part of the old plant and build a new one in its place by the fall heating season. Careful planning of delivery and erection schedules was necessary, and it was therefore decided to install two boilers and one turbine in 1938 and another boiler and turbine a year later.

Selection of Steam Conditions

A study of possible pressure-temperature combinations showed that the maximum that could be used was 625 lb gage and 825 F at the turbine throttle. The reasons for such a selection were:

1. The temperature worked out satisfactorily at the 190 lb and 3 lb extractions.
2. For condensing operation the moisture in the last stages of the turbine would be satisfactory.
3. The selection fitted the so-called series 60 for fittings and the schedule 100 to 120 for piping without the excessive use of alloy steels.
4. The initial investment weighed against return seemed to be most favorable at this point.
5. Some additional power would be made from the regenerative feedwater heating cycle.

A heat balance diagram was worked out as shown in Fig. 2. It should be noted that in addition to the steam required by the factory, a two stage regenerative feedwater heating cycle was incorporated into the power generating plan. A low pressure deaerating heater (Item 17, Fig. 2) was connected to the 3 lb extraction and a high pressure heater (Item 21, Fig. 2) connected to the 190 lb. This helped the economy of the station, especially in summer when condensing operation was necessary.

It was planned to operate the station at a demand that would allow most of the power to be made non-condensing. However, an analysis showed that it would pay to make condensing power in sufficient quantities to insure a steady supply to the factory. Such times would be the summer months and during warm

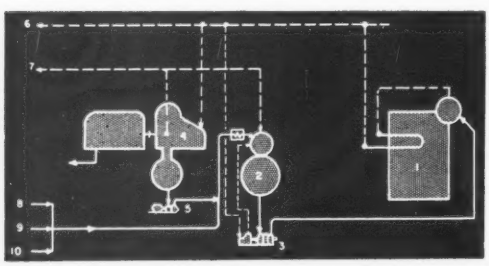


Fig. 1. Heat balance diagram of original station

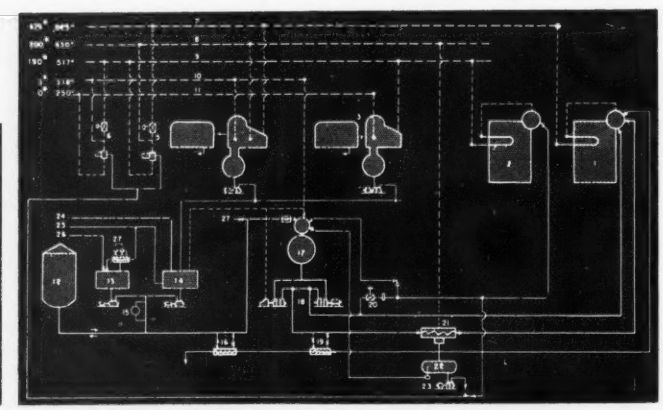
1. Steam boilers—12—500 hp units, 190 psi
2. Feedwater heater
3. Boiler feed pumps—2 units
4. Steam turbines—1—3000 kw unit; 1—2500; 2—1500
5. Condensate pumps
6. Steam to factory—190 lb
7. Steam to factory— 3 lb
8. Condensate return—manufacturing
9. Condensate return—heating
10. Make-up water

BASIC DESIGN FEATURES

Two 7500-kw double-extraction condensing turbine generators supplied with steam by two 100,000 lb per hr, 600 psi, 825 F pulverized coal or oil fired boilers . . . Process steam required at 190 psi, heating steam at 3 psi. . . . By careful analysis of steam and electrical loads most of the power is made by non-condensing operation, some by condensing operation. . . . Thus by careful proportioning, maximum use of the boiler room was attained and the turbines were in continuous use This article tells how they worked out over a 6-year period.

Fig. 2. Heat balance diagram of new station

1. Steam boilers—3 units—100,000 lb hr each, 640 lb, 825 F
2. Steam boilers—4 units—500-hp each —190 lb.
3. Steam turbines—one 3000-kw, one 2500-kw—190 lb
4. Steam turbines—2 units—7500-kw each—625 lb, 825 F
5. Reducing and desuperheating station—625 to 190 lb
6. Reducing and desuperheating station—190 to 0 lb
7. Station steam header—625 lb, 825 F
8. Extraction header—200 lb, 630 F
9. Steam to factory—190 lb, 517 F
10. Extraction header—3 lb, 318 F
11. Steam to factory—0 lb, 250 F
12. Surge tank
13. Condensate return tank heating
14. Condensate return tank manufacturing
15. Dirt and grease strainers
16. Blowdown heat exchanger low pressure
17. Deaerating heater
18. Boiler feed pumps—3 units—one steam, two motor
19. Blowdown heat exchanger high pressure
20. Reducing valve water to low pressure boilers
21. Feedwater heater high pressure
22. Distilled water storage tank
23. Booster pump for condensate
24. Condensate return manufacturing
25. Make-up water
26. Condensate return heating
27. Air removal for heating system



It is not often that we have an opportunity of presenting as complete an analysis of the operation of a modern industrial power plant as is this article by Mr. Biggs. It is a complete record of the operation of a 600 lb pressure plant of the General Electric Co. over a period of six years, from 1939 to 1944, inclusive. The average overall boiler room efficiency over the 6 year period was 72.2 per cent. Average cost of steam over the 6 years is approximately 50 cents per thousand pounds of 1000 Btu steam and the cost of power, ¾ cents per kwh. Experience here should guide others in planning for future

days in spring and fall. By careful proportioning the maximum use of the boiler room was obtained and the turbines were in continuous use.

Design of New Equipment

As two constant pressures were required, one at 190 lb for manufacturing and the other at approximately 3 lb for the heating system, and as condensing power was also desirable, double automatic extraction condensing turbines were selected. Although some extraction power was always available, it was decided to make the condensers large enough for full condensing operation. The generators are rated 7500-kw, 0.8-pf, 60-cycle, 3-phase, 13,800-v and have direct connected exciters. Cooling of the generators is accomplished by a closed system using finned surface air coolers and water from the circulating system.

A view of a turbine-generator is shown in Figure 3. Fig. 4 is a section of the turbine room and Fig. 5 is a section of the boiler room.

The condenser is a two-pass surface type with steel plate shell, cast iron water boxes, Muntz metal tube sheets filled with 8000 sq ft of Muntz metal tubes ¾ in. OD, 18 BWG.

Fig. 3. Two 7500-kw double-extraction condensing turbine-generators, instrument boards, and on the left the deaerating heater

Auxiliaries include one air cooler and after condenser assembly with two stage twin element air ejectors, two condensate removal pumps, and one circulating water pump. A 75-hp, 2923/490-rpm, turbine with a close-couple gear drive was used on the circulating pump for one 7500-kw unit and dual motor drive was used on the other. The steam drive was provided for starting from complete shutdown and for use during emergency interruptions. As very little steam was condensed during maximum extraction operation, one circulating water pump was arranged to run at two speeds by installing a large motor for summer use and a small gear motor for winter.

Design conditions were: steam load 70,000 lb per hr, absolute pressure 2 in. Hg with 80 F circulating water requiring 8900-gpm. The circulating water pump supplied 9100-gpm which included 200-gpm for the generator air coolers and lubricating oil coolers.

The boilers are designated as F-22-AG-14/48. The heating surface of the boiler and furnace is 9860 sq ft. The design pressure is 700 psi and the operating pressure at the superheater outlet is 640 psi at 825 F. The capacity at full load is 100,000 lb per hr each with a two hour overload to 125,000 lb.

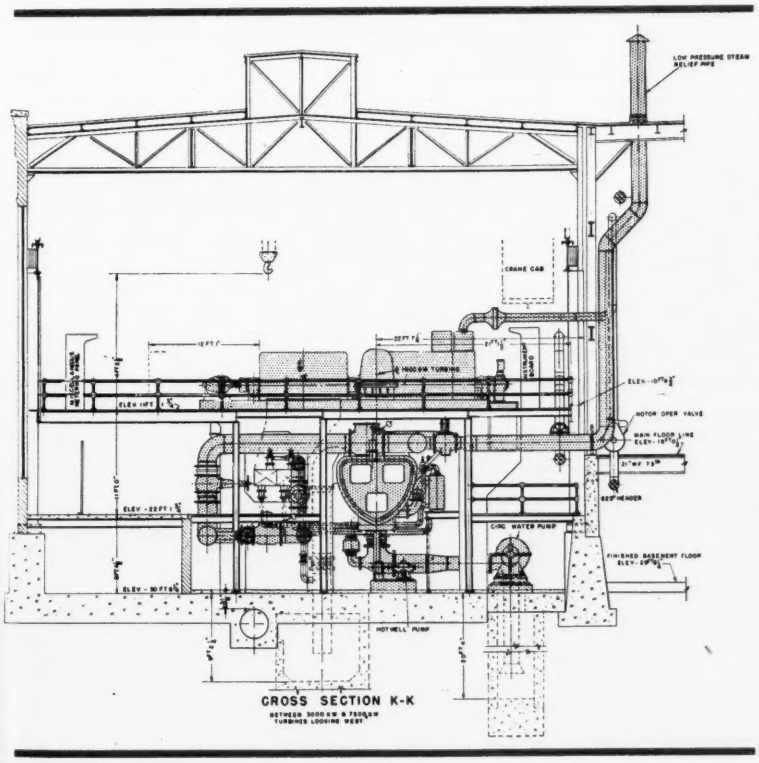


Fig. 4. Cross-section of turbine room showing 7500-kw turbine and condenser

Firing Methods

The basic design was for powdered fuel, but provision was also made

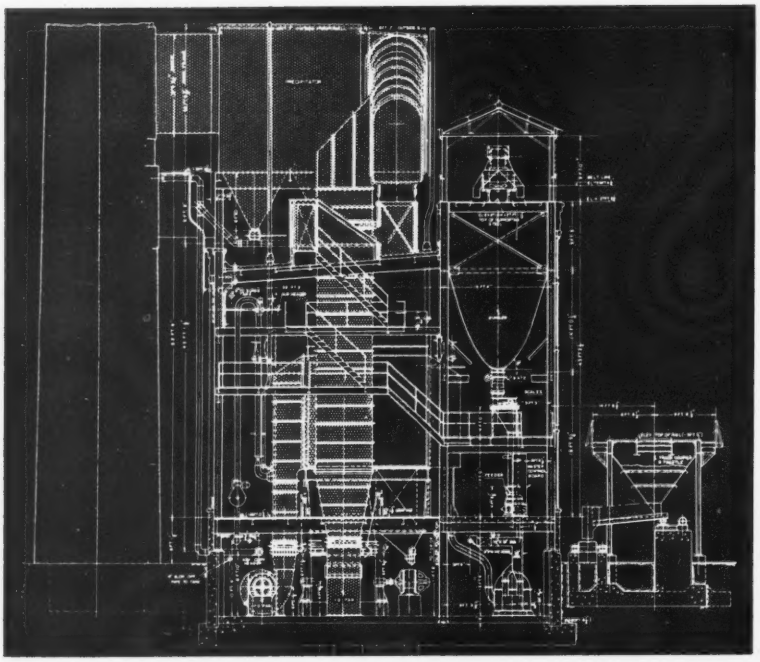


Fig. 5. Cross section of boiler room showing 100,000 lb per hr boiler, draft fans, and coal system

for oil firing as an alternate.

Two unit pulverizers with recirculator and low rating dampers were provided for each boiler. Each mill is driven by a 75-hp, 1150-rpm, induction motor through a pick-up type flexible coupling. The arrangement is shown in Fig. 8.

Two flare-type burners with dampers for regulating the air control were used for each boiler. Separate table-type coal feeders with magnetic separator were used and were driven by a ½-hp, 500-2000-rpm, d-c motor as shown in Fig. 6. Each burner was fitted with a steam atomizing oil gun.

The enclosure for the boilers was of the suspended-arch construction. This consisted of suspended refractory in the arch and walls supported by the necessary steel shapes, insulation of magnesia blocks, and a steel plate sealing shell over the outside.

The furnace wall tubes were covered with magnesia blocks and steel sealing plates. Fig. 12 is a photograph taken during erection of the boilers.

One forced and one induced draft fan were provided for each boiler.

The forced draft fan under maximum conditions delivers 44,500 cfm of air at 10.25 in. H_2O pressure. Outlet dampers are provided. The drive consisted of a 100 hp, 1150-rpm slip-ring induction motor.

The induced draft fan under maximum conditions handles 74,000 cfm of gas at 14.0 in. H_2O pressure. Cast iron scroll liners are provided for the housing. Inlet dampers are also used. The drive consisted of a 250 hp, 700-rpm slip-ring induction motor.

Provisions for Feedwater

To insure continuous operation of the high pressure boilers, the old low pressure boilers were used as evaporators and all raw water make-up was fed to them. Due to the lower operating temperature of the old boilers, water treating problems in them were not difficult. A small amount of sodium metaphosphate, potassium hydroxide, and potassium chloride is pumped directly to the drums of the high pressure boilers by chemical pumps. The factory condensate is somewhat contaminated, thus making this chemical treatment necessary.

The water is deaerated in a tray type deaerating heater designed for a final oxygen content of not over 0.03 cc per liter at 400,000 lb of water per hour. Approximately 10 min storage is provided.

The vent condenser, ejector and after-condenser, and parts of the float valves can be seen in the left-hand side of Fig. 3.

Water passes from the heater to the high pressure boiler feed pumps. Three of these pumps were provided and arranged as shown in Fig. 7. Two of them are driven by induction motors at 3600-rpm requiring 350-hp each, and one is driven by a steam turbine direct connected and arranged to start automatically in case the feedwater pressure falls below a predetermined value. The pumps are six stage, and are rated 500-gpm each at 1960 ft head.

The water passes from the boiler feed pumps through the high pressure heater where it is heated to approximately 370 F. The condensate from the heater is retained in a storage tank and used in the desuperheater in connection with the high and low pressure reducing systems.

Water level in the boilers is held by a three-element control which operates from meters measuring water level, and steam and water flow.

The boilers are equipped with fully automatic combustion control with necessary meters and instruments.

Two of the boiler boards are shown in Fig. 6 and the master control is shown in the center. A view of the turbine board is shown in the center of Fig. 3.

Coal Handling

A view of the coal handling equipment is shown in Fig. 13. The main equipment consists of a track hopper for unloading, a belt conveyor to the crusher house, the crusher house

Table I—Cost of Equipment and Installed Cost

Item No.		1 Equipment Cost	2 Installed Cost
1.	Boiler room equipment	$ 467,000	$ 643,000
2.	Turbine room equipment	234,000	280,000
3.	Feedwater equipment	59,200	77,400
4.	Wiring and power equipment	170,000	245,000
5.	Steam and water piping	128,600	184,200
6.	Building and galleries	131,500	238,000
7.	Preparing site and contingencies	.....	149,500
8.	Engineering and supervision	.....	94,500
		$1,190,300	$1,911,600

On opposite page

Fig. 6. Arrangement of table top coal feeders and instrument boards

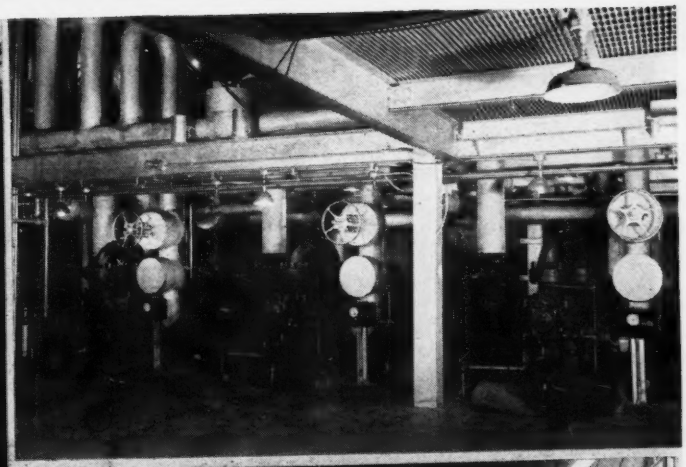
Fig. 7. Two motor and one steam driven boiler feed pumps—six stage, 3600-rpm, 1960 ft head, 500-gpm

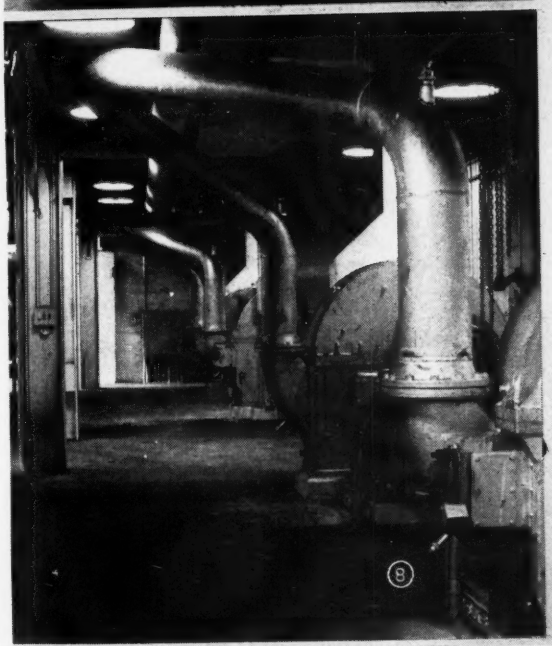
Fig. 8. Arrangement of unit pulverizers

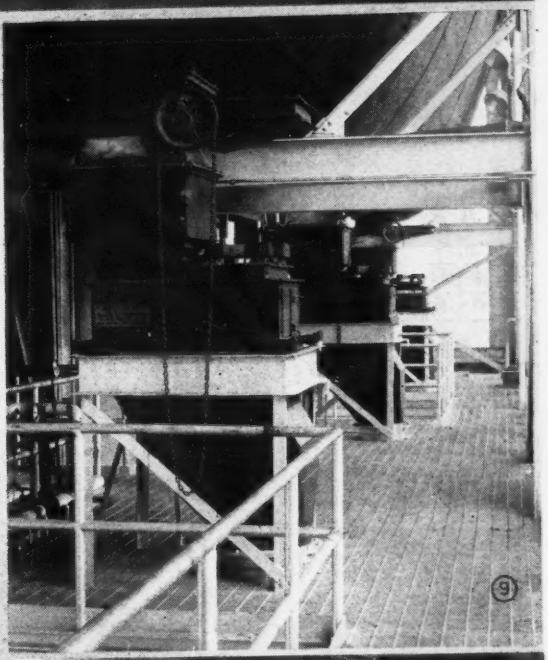
Fig. 9. Coal scales and bin shutoff gates

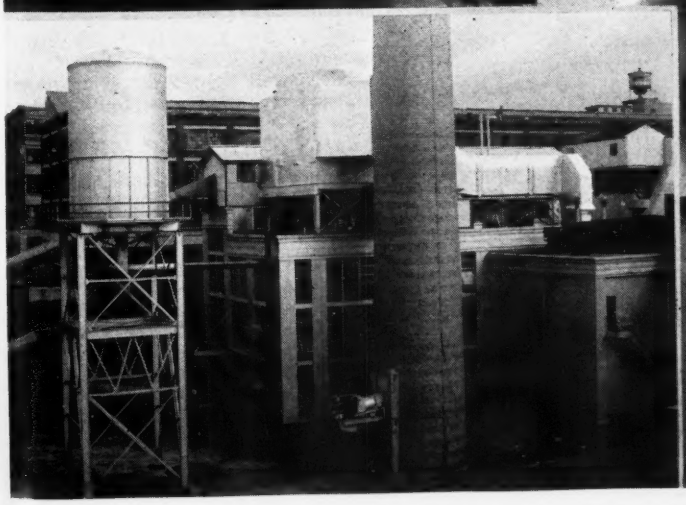
Fig. 10. View of outside of boiler room and switch house

Fig. 11. AE1B board for feeders less than 60-hp









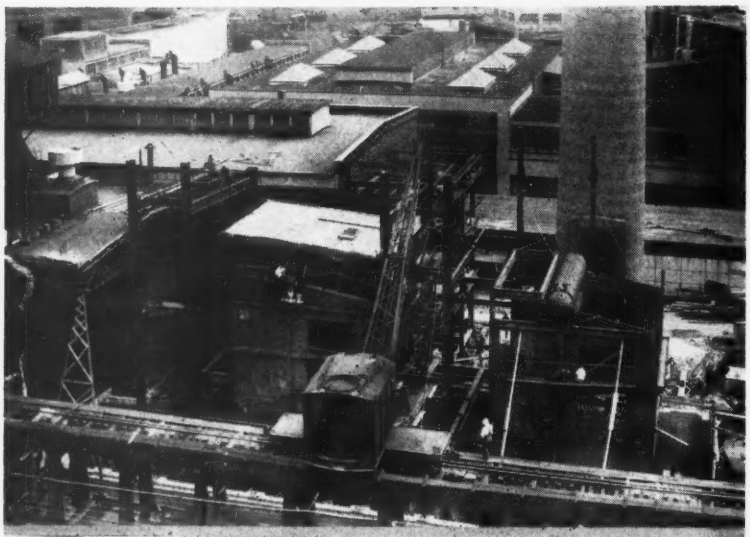


Fig. 12. Top, 100,000 lb per hr, 825 F boilers during erection

Fig. 13. Middle, coal handling conveyors and crusher building

Fig. 14. Bottom, coal yard showing trolley rail and scraper

which contained a magnetic separator, a ring roll crusher, a car mover, and the equipment for storing and reclaiming coal. A conveyor from the house into the storage bunker and a conveyor from the yard reclaiming pit into the crusher house are provided.

From the crusher house coal can be sent to the storage yard or to the bunkers. Reclaimed coal goes through the magnetic separator and the crusher.

Coal is stored and reclaimed by means of a dragline system shown in Fig. 14. The outer end of the dragline is moved about the pile by a trolley and winch operated from the tower. The yard has a capacity of 7000 tons and the equipment was set up to handle 150 tons an hour. The belts are 30 in. wide.

Coal is weighed to each boiler through automatic enclosed type coal scales shown in Fig. 9. The capacity of each scale is 8000 lb per hr. The ash handling system is of the pneumatic type.

As the discharge from the electric precipitator entered the existing stack at some distance from the ground, the steam ejector, cyclone separator, ash bin and unloader were placed inside the unused portion of the stack.

A view of the unloader is shown in the lower part of the stack in Fig. 10. Some of the connections and piping can be seen under the precipitator. The precipitator and gas flues are also shown at the top of Fig. 10. The old ash bin and tower were rebuilt and made into a 30,000 gal surge tank which is shown at the left of the picture.

Electrical System

The old part of the station was built for 2-phase power so it was decided to build a new auxiliary power substation in a metal panel addition to the main turbine room as shown on the right-hand side of Fig. 10. The outdoor transformers are at the base of the building. Fig. 11 shows the distribution board with the air breakers for feeders less than 60-hp. The automatic switchgear with 3000-ampere breakers is shown in Fig. 15. The control for the main generators is shown in Fig. 16. A modern well lighted office and conference room were added to the power house.

Costs and Performance

A summary of the cost of equipment and the total cost installed is given in Table I.

By dividing the 15,000 installed kilowatts into the total cost of $1,911,600, a cost of approximately $127 per kw is obtained. This is higher than would be obtained if the plant was for power generation only, as the boiler room was based upon supplying a large amount of steam to the factory.

Column 1 shows the cost of equipment only and column 2 shows the installed cost of equipment ready to

Fig. 15. Automatic switchgear—3000-amp, AL-2, breaking switching equipment

run plus contingencies and engineering.

A summary of the operating performance of the plant over the years from 1939 to 1944 inclusive is shown in Table II. The unit cost of coal and oil is given in this Table and the method of calculating the total cost of fuel is shown so that any other cost of fuel can be substituted if desired. It is interesting to note that the average overall boiler room efficiency is approximately 72.2 per cent, although the high pressure boilers will show about 85 per cent on a test run and the low pressure boilers will do better than 70.

A summary of the operating cost data is shown in Table III. An interesting item is the unit cost of steam and electric power. The average cost of steam over the six years is approximately 50c per 1000 lb of 1000-Btu steam and the cost of power is ¾c per kw-hr.

Other operating data is shown in Table IV. Information which may be of use in future planning is Item 22, which shows an actual steam rate of about 40 lb per kw-hr down to the 190 lb extraction and a rate of about 15 lb to the 3 lb opening. The condensing water rate averaged approximately 10 lb per kw-hr as indicated in Item 37.

Operating Experience

The auxiliary power, Items 46 and 47, shows that approximately 6.5 per cent was required for both boiler and turbine rooms. A few things which might be mentioned in connection with operation are as follows:

An attempt was made to operate

TABLE II. Summary of actual performance of the station

Item		1939	1940	1941	1942	1943	1944
1.	QUANTITIES OF HEAT IN MILLION BTU						
2.	Condensing Power 625 lb. Units (note 3)	215,000	284,000	272,000	795,000	929,000	1,123,000
3.	Condensing Power 190 lb. Units	81,300	64,700	277,000	680,000	13,200	23,800
4.	190 lb. Steam to Factory	475,000	501,500	603,000	648,000	663,000	676,000
5.	3 lb. Steam to Factory	195,000	220,000	249,000	256,000	231,000	156,300
6.	Non-Condensing Power (Note 1)	43,450	93,900	92,200	118,300	123,400	104,700
7.	Auxiliaries	3,000	3,000	3,000	4,000	4,000	4,000
8.	Total Distributed Requiring Fuel	1,012,750	1,167,100	1,496,200	1,889,300	1,964,400	1,997,800
9.	190 lb. Steam to Heater	124,400	219,000	259,000	312,000	281,000	250,000
10.	3 lb. Steam to Deaerator	43,200	71,800	60,200	82,400	111,700	118,500
11.	Total Steam from Boilers	1,180,350	1,457,900	1,815,400	2,283,700	2,357,100	2,366,300
12.	QUANTITIES OF POWER IN 1000 KW HRS (Note 2)						
13.	By-Product Power 190 lb. Extraction	8,230	11,060	12,700	16,900	15,320	14,650
14.	By-Product Power 3 lb. Extraction	3,817	15,028	12,900	16,000	18,950	14,450
15.	Condensing Power 625 lb. Units	17,256	18,260	21,234	58,601	68,297	77,415
16.	Condensing Power 190 lb. Units	4,734	3,784	13,923	3,776	673	1,209
17.	Total Generated Power	34,037	48,132	60,757	95,297	103,240	107,724
18.	Turbine Room Auxiliaries (Minus)	—645	—750	—1,429	—1,258	—483	—683
19.	Net Power Generated Per Year	33,392	47,382	59,328	94,039	102,757	107,041
20.	FUEL COST						
21.	BTU in Steam to All Services x Mil.	1,012,750	1,167,100	1,496,200	1,889,300	1,964,400	1,997,800
22.	Boiler Room Efficiency	74.3	69.5	69.1	73.4	74.2	73.2
23.	Total BTU from Fuel (Million)	1,363,000	1,680,200	1,163,300	2,575,000	2,652,400	2,731,000
24.	BTU from Coal (Million)	673,000	1,288,000	1,584,000	2,367,000	2,596,000	2,395,000
25.	BTU from Oil (Million)	690,000	392.200	579,300	208,000	56,400	336,000
26.	Tons Coal per Year	23,344	44,420	54,699	81,640	89,507	82,649
27.	Gallons of Oil x 1000	4,495	2,552	3,776	1,353	368	294
28.	Heat Value Coal BTU per lb.	14,450	14,492	14,488	14,488	14,488	14,488
29.	Heat Value Oil BTU Gal.	153,521	153,521	153,521	153,521	153,521	153,521
30.	Cost of Coal per Ton	5.61	5.74	5.957	6.462	7.03	7.62
31.	Cost of Oil per Gal. x 1000	32.65	37.46	39.99	41.82	51.50	50.02
32.	Total Cost of Fuel Dollars	$287,158	$350,306	$475,049	$585,504	$648,570	$739,431

NOTES:
1—Obtained from Item 13 and 14 x 3600 BTU an Hour
2—Obtained from Table IV Items 23, 30, 35, and 40
3—Obtained from Table IV Item 36 x Item 32

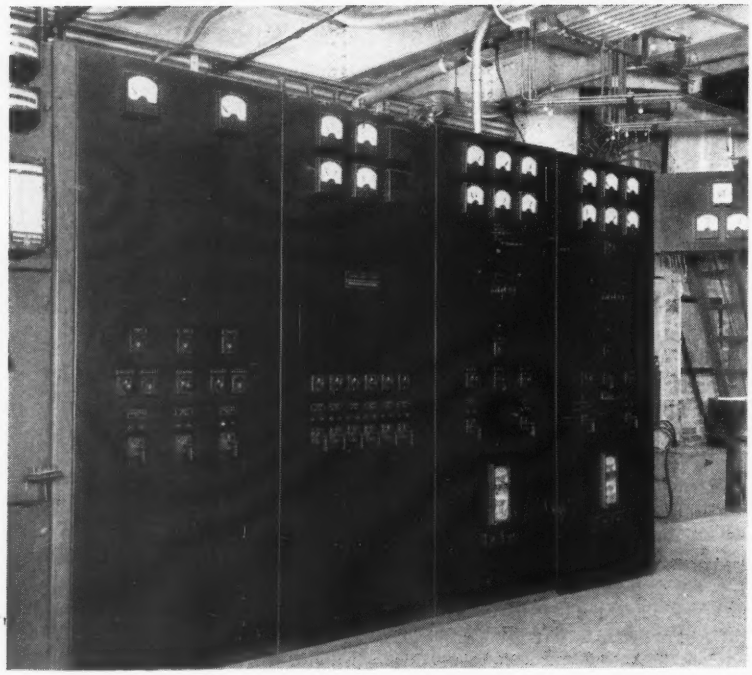


Fig. 17. Electrical control boards for 7500-kw generators

the high pressure boilers on a combination of about 75 per cent return condensate and 25 per cent raw make-up water from the city. This water had an analysis as follows:

Hardness	40-60 ppm
Alkalinity	20-30 ppm
Solids	50-70 ppm
Chlorides	10-12 ppm
pH	7

Tube failures began to occur after about three months and various attempts at internal treatment were unsuccessful, so the old boilers were used as evaporators and the new boilers given all the condensate. Once a year the boilers are pickled with a solution of hydrochloric acid and then washed down with water.

The process of the mechanics of the deposits which caused internal treatment to be a failure seemed to have been centered around the fact that there were sufficient silicates in the make-up water to form gelatinous aluminum silicates which acted as a binder for the sodium phosphate sludges formed.

At a future date it is planned to install evaporators to take the place of the old boilers.

The boiler refractories have stood up well. However, about 35 per cent of the boiler furnace floor area has had to have the blocks repaired each year. Two of the boilers had to have some work done on the third pass baffle. The induced draft fans have had the wearing blades replaced once.

Tube Coating

The tube bundle of the high-pressure heater on the steam side became coated with a substance which only a petroleum ether solvent would remove. Some signs of the tube corrosion in the vent condenser of the main deaerator have become evident. The pulverizers were doing about 15,000 tons of coal before being repaired, which is about a year's oper-

Table III. Summary of actual cost of producing power and steam

Item No.	Item		1940	1941	1942	1943	1944
1.	COST OF STEAM						
2.	Fuel (Note 1)	$ 287,158	$350,306	$475,049	$585,504	$648,570	$739,431
3.	Labor (Operating)	33,286	33,304	46,038	72,232	76,254	75,215
4.	Expense	6,438	5,398	7,437	9,292	6,982	9,874
5.	Auxiliary Power	20,598	27,369	43,815	39,336	40,754	53,975
6.	Maintenance	31,316	34,475	45,376	53,186	44,858	43,145
7.	Fixed Charges	18,891	20,316	26,140	19,040	24,072	17,340
8.	Depreciation	125,076	105,094	107,174	124,574	125,204	113,840
9.	Total Cost Steam	522,763	576,262	751,023	903,164	966,694	1,052,820
10.	Total Lbs. x 1000 (Note 2)	1,012,750	1,167,100	1,496,200	1,889,300	1,964,400	1,997,800
11.	Cost in ¢ per 100 lbs.	51.6	51.6	50.2	47.8	49.2	52.7
12.	Lbs. Chargeable to Power (Note 3)	339,750	442,600	641,200	981,300	1,066,400	1,251,500
13.	COST OF POWER						
14.	Steam (Item 11 x Item 12)	175,300	228,800	322,000	468,700	525,000	660,000
15.	Labor (Operating)	12,831	15,140	19,744	21,177	15,687	16,437
16.	Expense	2,834	2,832	4,503	4,586	2,063	2,513
17.	Auxiliary Power	5,303	5,212	11,765	4,663	3,452	6,140
18.	Maintenance	7,984	7,696	13,537	29,122	60,911	11,576
19.	Fixed Charges	6,585	12,192	16,217	14,740	18,770	12,308
20.	Depreciation	37,391	79,999	81,576	120,133	120,744	109,784
21.	Total Cost Power	248,048	351,871	459,342	663,121	746,627	818,758
22.	Net Kilowatt Hrs. Generated (x 1000) (Note 4)	33,392	47,382	59,328	94,039	102,757	107,041
23.	Cost in ¢ per Kw. Hour (Item 21 ÷ Item 22)	.744	.743	.792	.705	.726	.765
24.	COST OF POWER AND STEAM						
25.	Fuel	287,158	350,306	475,049	585,504	648,570	739,431
26.	Labor	46,117	48,444	65,782	93,409	91,941	91,652
27.	Expense	9,092	8,230	11,934	13,878	9,045	12,837
28.	Auxiliary Power						
29.	Maintenance	39,300	32,581	58,913	82,308	105,769	54,721
30.	Fixed Charges	25,476	32,508	42,357	33,780	42,842	29,648
31.	Depreciation	162,467	185,093	188,750	244,707	245,948	223,624
32.	Total Cost of Power and Steam	569,160	657,262	842,785	1,053,586	1,144,115	1,151,913
33.	Generated Demand KW per Hour	9,600	12,000	11,900	19,000	18,600	19,300

NOTES:
1—Obtained from Table II Item 22
2—Obtained from Table II Item 8 on Basis of 1000 BTU per Lb. of Steam
3—Obtained from Table II Items 2, 3 and 6 on Basis of 1000 BTU per Lb.
4—Obtained from Table II Item 19

ation. Lately due to poorer grades of coal this has been reduced to 10,000 tons.

The principal maintenance items of the ash system were wearing parts of ash separators and receivers.

In the cold winter weather (0 to 30 F below zero) coal that is reclaimed from the stock pile is quite frosty and is often hard to get started up the belt and sometimes after it is running, will slide down. The solution was to warm up the coal.

Samples of steel were recently cut from welds that had been operating at 825 to 850 F continuously since the plant started and no carbonization could be detected.

Table IV. Complete operating data

Item No.		1939	1940	1941	1942	1943	1944
	Steam Produced						
1	Steam From 190 Lb. Boilers (Actual) x 1000	95 799	226 154	280 717	107 979	19 687	166 290
2	Steam From 625 Lb. Boilers (Actual) x 1000	946 337	911 651	1 146 915	1 666 011	1 786 471	1 775 717
3	Pressure at Boilers #G	185/619	179/617	179/616	190/616	188/610	184/623
4	Superheat at Boilers Deg. F.	108/281	112/312	122/303	133/293	138/308	119/301
5	Feed Water to Boilers Deg. F.	208/378	214/365	206/352	209/346	206/334	213/330
6	Total Heat BTU per Lb. 625 Lb. Boilers	1 400	1 409	1 403	1 396	1 406	1 403
7	Average Heat in Steam at 190#	1 259	1 262	1 258	1 276	1 276	1 267
	Steam Disbributed in Pounds (x 1000)						
8	Steam to 190# Turbines (Actual)	68 437	54 725	238 334	57 301	11 165	20 218
9	Steam to Condensers of 625 Lb. Units (Actual)	160 494	209 149	202 747	595 102	697 087	843 708
10	3 Lb. Steam to Factory (F&A)	200 834	226 597	263 270	161 084	237 268	161 084
11	190 Lb. Steam to Factory (F&A)	489 069	516 397	620 094	668 219	684 292	697 256
12	Steam to Auxiliaries (Boiler Room)	52 873	12 058	14 132	30 360	25 500	87 570
13	Steam to Auxiliaries (Turbine Room)	166	1 026	80	1 745	3 043	4 810
14	Steam to High Pressure Heater (F&A)	128 230	225 315	262 050	321 547	289 356	257 403
15	Steam to Deareating Heater (F&A)	44 503	74 000	62 000	85 000	115 000	122 131
	Operating Data 625 Lb. Units						
16	Steam to Throttle 625 Lb. Units (Actual Lb. x 1000)	427 469	794 283	810 845	1 588 110	1 784 521	1 744 863
17	Steam From 190 Lb. Extraction (Actual x 1000)	254 616	356 818	415 936	745 200	799 309	685 821
18	Pressure at Extraction (190#) G.	182	182	179	187	188	186
19	Temperature at Extraction (190#)	527	554	544	584	629	609
20	Total Heat in Steam (Per Lb.)	1 285	1 298	1 293	1 314	1 337	1 326
21	Heat Available For Power (Per Lb.)	115	111	110	82	69	77
22	Steam Rate at (190 Lb. Extraction)	31.4	32.2	32.7	44.0	52.2	46.7
23	Kilowatt-Hours Generated at 190 Lb. Extraction (x 1000)	8 230	11 060	12 700	16 900	15 320	14 650
24	Steam From 3 Lb. Extraction Actual (x 1000)	8 359	218 316	192 162	247 808	288 125	215 334
25	Pressure at Extraction (3 Lb. G)	0.5	0.3	1.3	1.7	1.4	1.6
26	Temperature at Extraction 3 Lb.(F)	233	240	237	241	249	237
27	Total Heat in Steam at 3 Lb. Extraction	1 161	1 164	1 162	1 164	1 168	1 162
28	Heat Available for Power (Per Lb.)	239	245	241	232	238	241
29	Steam Rate at 3 Lb. Extraction	15.05	14.70	14.90	15.5	15.2	14.9
30	Kilowatt-Fours Generated by 3 Lb. Steam Main Units	539	14 830	12 900	16 000	18 950	14 450
31	Heat Returned in Condensate (625 Lb. Units)	60	60	64	59	78	77
32	Heat Chargeable to Power 625 Lb. Units (Per Lb.)	1 340	1 349	1 340	1 337	1 328	1 324
33	Total Kilowatt-Hours Generated 625 Lb. Units (x 1000)	26 025	44 150	46 834	91 521	100 947	106 515
34	Total Kw-Hr. Generated Non-condensing (625 Lb. Units) (x 1000)	8 269	25 890	25 600	32 920	34 270	29 100
35	Total Kw-Hr. Generated Condensing (625 Lb. Units) (x 1000)	17 256	18 260	21 234	58 601	66 777	77 415
36	Steam to Condenser 625# Units (Actual)	160 494	209 149	202 747	595 102	697 087	843 708
37	Steam Rate to Condenser (625 Lb. Units)	9.3	11.45	9.52	9.95	10.44	10.08
	Operating Data - 190 Lb. Turbines						
38	Steam to Condenser 190 Lb. Units (Actual) x 1000)	68 437	54 725	238 334	57 301	11 165	20 218
39	Steam from 3 Lb. Extraction (Actual) (x 1000)	13 309	15 099	0	6 995	0	0
40	Total Kw-Hr. Generated on 190 Lb. Units (x 1000)	4 734	3 784	13 923	3 776	673	1 209
41	Heat in Condensate 190 Lb. Turbines - Btu Lb.	72	81	107	88	93	90
42	Steam Rate Old Units	14.5	14.5	17.1	15.15	16.7	16.7
	Power Generated						
43	Power Generated 190 Lb. Units - 1000 Kw-Hr.	4 734	3 784	13 923	3 776	673	1 209
44	Power Generated 625 Lb. Units	26 025	44 150	46 834	91 521	100 947	106 515
45	Total Kilowatt-Hours Generated (x 1000)	46 845	58 900	82 649	105 243	114 649	118 990
46	Power to Auxiliaries - Turbine Room	645	750	1 429	1 258	483	683
47	Power to Auxiliaries - Boiler Room	2 689	3 924	5 161	5 547	5 659	6 011
	Fuel Burned and Total Heat Released						
48	Tons Coal Burned (2000 Lbs.)	23 344	44 420	54 699	81 640	89 507	82 649
49	BTU per Lb. Coal (Dry)	14 450	14 492	14 488	14 488	14 488	14 488
50	Total BTU from Coal (Million)	673 000	1 288 000	1 584 000	2 367 000	2 596 000	2 395 000
51	Oil Burned in Gallons x 1000	4 495	2 552	3 776	1 353	368	2 194
52	Heat Value of Oil per Gallon BTU	153 521	153 521	153 521	153 521	153 521	153 521
53	Total BTU From Oil (Millions)	690 000	392 200	579 300	208 000	56 400	338 000
54	Total BTU Both Oil and Coal (Million)	1 363 000	1 680 200	2 163 300	2 575 000	2 652 400	2 731 000
	Station Efficiency						
55	BTU to Condensing Power 625 Lb. Units x Million	215 000	284 000	272 000	795 000	929 800	1 123 000
56	BTU to Condensing Power 190 Lb. Units x Million	81 300	64 700	277 000	48 000	13 200	23 800
57	Million BTU to Factory (190 Lb.)	475 000	501 500	603 000	648 000	663 000	676 000
58	BTU to Factory at (3 Lb.) Million	195 000	220 000	249 000	256 000	231 000	156 300
59	BTU in Non-condensing Power x Million	43 450	93 900	92 200	118 300	123 400	104 700
60	BTU to Auxiliaries x Million	3 000	3 000	3 000	4 000	4 000	4 000
61	BTU to Services x Million	1 012 750	1 167 100	1 496 200	1 889 300	1 964 400	1 997 800
62	BTU From Coal and Oil X Million	1 363 000	1 680 200	2 163 300	2 575 000	2 652 400	2 731 000
63	Station Efficiency (Percent)	74.3	69.2	69.2	73.3	74.0	73.2
	Miscellaneous Data						
64	Make-up Water in Pounds x 1000	182 900	273 000	481 000	293 000	301 000	247 000
65	Make-up Water for Factory in Pounds x 1000	-	-	-	176 000	176 000	170 000
66	Make-up Water for Boilers in Pounds x 1000	-	-	-	117 000	125 000	77 000
67	General Condensate Temperature - Degrees F	168	140	151	151	141	128
68	Barometer Average	28.9	28.9	28.9	28.9	28.9	28.9
69	ABS'L Pressure 190 Lb. Turbines	2.3	2.9	5.7	3.5	4.0	3.7
70	ABS'L Pressure 625 Lb. Turbines	1.0	1.2	1.7	1.5	2.4	2.1

Maintenance of Lubricating Oils for Prime Movers

By **BEN F. HUNTER** Consulting Engineer, Honan-Crane Corp., Subsidiary of Houdaille-Hershey Corp.

LUBRICATION of prime movers, by necessity, is one of our most exacting lubricating problems. In the earlier designs of the reciprocating steam engine, our knowledge and the science of lubrication was limited, and little thought was given to proper application. In general, lubricants were applied by hand oiling and/or drip cups, both of which rely on the human element for application.

Where hand oiling and drip cups provided lubrication, the oil was used only once; hence the quality of the oil with reference to its stability or resistance to decomposition was not a factor.

When the steam turbine and the internal combustion engine were developed, hand application of lubricants was inadequate; and the splash, bath, and circulating oiling systems came into existence. In this type of oiling system where the lubricant is used over and over again, stability and resistance to decomposition became factors of importance. Refiners met the challenge and the improvement in quality of our lubricating oils during the past decade has been outstanding. With the selection of crudes, better refining methods, and the discovery of the oxidation inhibitor, petroleum lubricants are now available which, when properly maintained in service, have an unpredictable life.

Petroleum Lubricants

Petroleum lubricants are a highly complex mixture of the elements hydrogen and carbon united to form molecules having millions of different molecular structures. Each molecule, depending upon its molecular structure, possesses inherent properties with reference to resistance to decomposition.

In the process of refining, the different petroleum fractions are separated or fractionated according to their boiling point. The smaller the number of carbon atoms per molecule the lower the boiling point and viscosity. Conversely, the greater the number of carbon atoms per molecule, the higher the boiling point and the viscosity.

When the hydrocarbons are separated to within a predetermined range of boiling points and viscosities they are then subjected to treatment by various chemicals, classified as refining processes, to remove those hydrocarbons which, by virtue of their molecular structure, are most susceptible to decomposition in service.

Petroleum lubricants are oxidizable and in service are oxidized and decomposed at a rate depending upon the severity of service and the quality of the oil.

Petroleum lubricants do not wear out but are rendered unfit for continued use as a result of contamination by foreign materials, either solids or liquids, and the oxidation of the hydrocarbons themselves. The percentage of contaminants in a given lubricant which may render it unsuitable for continued service may be very small (one to five per cent, depending upon the nature of the contaminants and service), yet ninety-five per cent or more of the lubricant may be in its original condition.

During more recent years, lubricating oil maintenance equipment, including purifiers, filters, centrifuges, etc., have been perfected and, when properly selected for a given service to completely remove objectionable contaminants as they are created or find their way into an oiling system, have proven that the useful life of an oil is unpredictable. In many of our major units, lubricating oils have been in service from fifteen to twenty years and are still in their original condition.

When contaminants of a foreign nature and products of oxidation of the oil itself are allowed to accumulate in the oil in minor percentages, they act as catalysts to accelerate the decomposition of the oil and shorten its useful life; whereas, if constantly removed and held to within certain limits, the life of the oil may be years instead of months. The selection of lubricating oil maintenance equipment must be made in accordance with the nature of the contaminants if the maximum of results is to be expected. Due to the decided improvement in the quality of our lubricating oils, it is felt that, in far too many instances, we expect too much of them.

It should be remembered that contaminants in a quality lubricant are just as objectionable as they are in a poor grade lubricant. Far more can be accomplished in improved lubrication throughout industry by combatting contaminants than can be

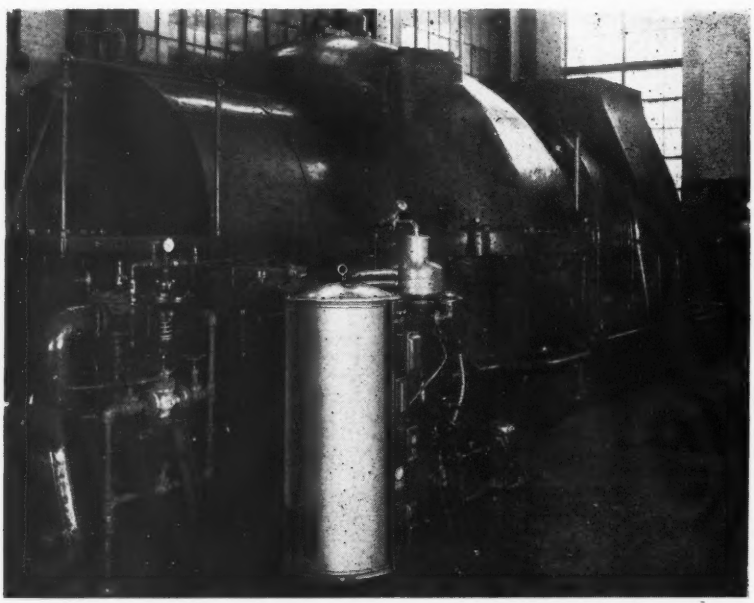


Fig. 1. Honan-Crane purifier installed on 30,000-kw Westinghouse turbine. This turbine has an oil capacity of 1800 gal

Characteristics of petroleum lubricants. . . . Why and how life of lubricant may be extended from months to years. . . . Combating contaminants accomplishes more than improvement of lubricants. . . . Factors in steam turbine lubrication: effect of rust inhibitors. . . . Internal and external lubrication of reciprocating steam engines. . . . Lubrication of internal combustion engines presents severest problems of all prime movers. . . . Effects of high temperature on internal combustion engine lubrication. . . . Effects of detergent types of oils

realized by improved or quality lubricants. The science and knowledge of adequate oil purification and maintenance equipment is fast becoming recognized throughout industry, and its more general adaptation may be expected as its value and economy becomes more generally understood.

Prime movers may be divided into three general classes:

1. Steam (steam turbine and reciprocating steam engines).
2. Hydro-electric.
3. Internal combustion engine (gas, gasoline, and Diesel).

Steam Turbine

The steam turbine, due to the close tolerances and the high rubbing speeds of the bearings, presents one of our most critical lubricating problems; yet it has been so completely mastered that bearing failures in steam turbines are seldom encountered. The adaptation of the circulating system, employing the highest grade, clean oil for the lubrication of the steam turbine, is an outstanding example of what can be expected in the lubrication of machines in general when properly designed to take full advantage of the science of lubrication.

In the earlier designs of steam turbines and with the quality of oil then available, it was common practice to change oils every six months to a year, or slightly more; whereas, today many of our turbines have been operating for fifteen years or more on the same oil which is still in perfect condition. Water and abrasives, either dust, dirt, fly ash, iron oxide, etc., are the contaminants which operators watch and hold to within limits consistent with the best operating practice.

In the modern turbine oiling system, a copious quantity of oil is supplied to the bearings which provides lubrication and carries away transmitted heat or heat generated within the bearing. Heat exchangers or oil coolers serve to hold oil temperatures within definite limits. Temperature control of lubricating oils is all-important when we realize the rate of oxidation doubles with each 18 F rise in temperature, say above 140 F. Our modern lubricating oils plus the oxidation inhibitor are remarkably stable or resistant to oxidation at temperatures approximating 140 F as compared to temperatures of 185-200 F.

The hazards in turbine operation presented by corrosion in the oiling system during the past few years have become recognized and widely discussed. To improve this hazardous condition, turbine oils containing so-called "rust inhibitors," to minimize the tendency of entrained water to corrode the surfaces of the metal with which it comes in contact, are now generally offered by major refiners.

Oils containing rust inhibitors have proven their value, particularly in starting up new installations where water contamination may be encountered. Rust inhibitors and their action may vary slightly from one refiner to another; but, in general, the so-called "plating type" of rust inhibitor appears to be the most promising. In this type of rust inhibitor, polar compounds which have a preferential wetting power for metal over water are added (not chemically combined) to the oil; and, when circulated throughout the system, precipitate or plate out on the surface of the metal, forming a film which prevents water from coming in contact with the metal and subsequent corrosion. Unfortunately, the most effective rust inhibitors employed to date impair other desirable properties in an oil, particularly its ability to quickly drop entrained water, usually apparent by increase in steam emulsion number.

The use of oils containing rust inhibitors is new but is increasing, and no one can predict its ultimate value or what improvements petroleum technologists may be able to accomplish in overcoming any objectionable

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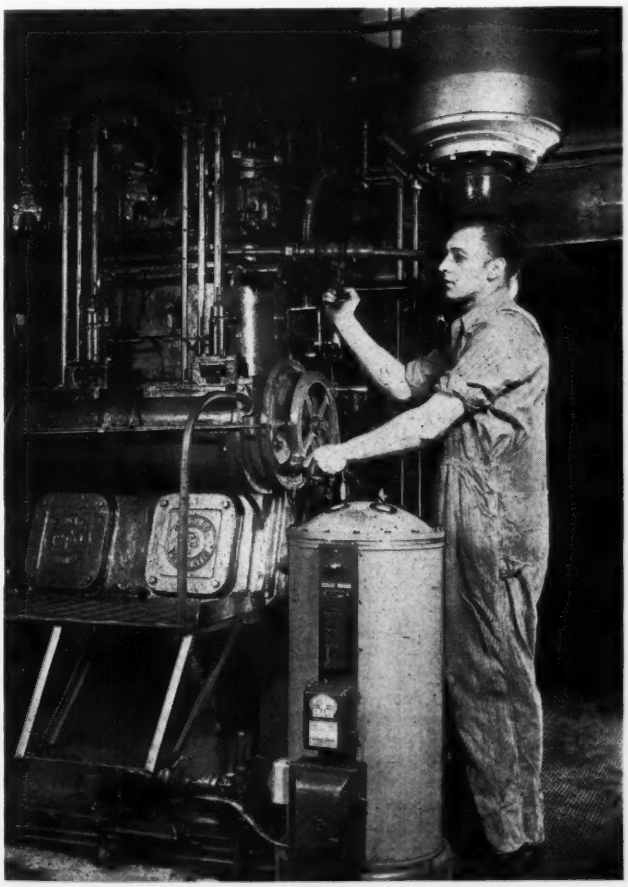

Fig. 2. Honan-Crane purifier installed on a 400-hp Chicago Pneumatic 4-cycle Diesel at Armstrong Paint Co., Cleveland, O. Four purifiers connected to Diesels at this plant. Prior to installation of this equipment, oil was changed every 500 hr. Now they use same oil, save 25 per cent on lubricating costs; maintenance simplified

Corrosion in Vertical Turbine Pumps*

By **T. E. LARSON** Chemist, State of Illinois, State Water Survey Diviion

1. Dependence of Illinois municipalities and industries upon well water.
2. Schemes for meeting recession of water levels.
3. Why corrosion of deep well pumps is expected.
4. Galvanic action, a principal cause of corrosion, is explained.
5. Certain pump parts, vulnerable to corrosive attack of CO_2, are listed.
6. Stray currents and cathodic protection treated briefly.
7. Protective coatings listed.
8. Use of acid for removing deposits in pumps explained.

AROUND 360 million gallons of water are pumped per day from some 3000 wells for about 1300 municipalities and industries in Illinois. A high proportion of these wells are equipped with turbine pumps. Within a 25 mile radius of Chicago there are about 500 municipal and industrial turbine pumps supplying about 85 mgd. About 275 of these turbine pumps supply about 70 mgd from wells penetrating the deep sandstones.

*From a paper presented before the National Association of Vertical Turbine Pump Manufacturers.

With non-pumping water levels receding in these wells as rapidly as 8 ft and in some cases 20 ft per year, it is not surprising to find that pump settings for these 275 pumps range as follows:

10 per cent 200 ft and less
30 per cent 201-300 ft
30 per cent 301-400 ft
25 per cent 401-500 ft
5 per cent 501-600 ft

The capacities of these pumps range from 50 to 2000 gpm.

By virtue of these settings the cost of pulling these pumps and the cost of replacing column pipe, shaft, and shaft tube is an item that can often amount to $6000 per replacement. A little added cost for initial pipe protection can multiply the life to this portion of the installation several fold.

Water Level Recession

The observed water level recession in these wells will necessarily result in lower settings for nearly all pumps in the near future. Conservation will slow up the rate of recession, but nothing can avert the eventual approach to one or more of the following alternatives:

1. Lower pump settings limited by the efficiency of pumps for the present well bore diameters and relative economics of water from another source.
2. Use of surface water, lake or treated river water.
3. Recharge of water-bearing strata using cold water for recharge and withdrawing same in summer. This would of necessity be a cooperative measure, and the feasiblity may be open to serious question.
4. Use of warm water from greater depths for limited specific purposes.

Extreme conservation methods would force prospective and some established industries to resort to one of the last three alternatives. Since the best definition of "conservation" is "intelligent use" it would appear that the water users in a critical area organize and promote their own conservation methods, exchange data and information and utilize the available but not generally well-known factual data and methods for "intelligent use."

At many of these installations the quality of the water is such that corrosion can be expected. Although as a general rule water quality does not play a serious role unless the mineralization is greater than 700 ppm, it is not unusual to find that waters of 2000 to 3000 ppm mineral content are used.

At the present time is is a rarity to find a pump removed from a well in this vicinity that has not been subject to corrosion to some extent.

A recent inspection of 11 deep well turbine units abandoned by the C. M. & St. P. & P. R. R. showed that 7 were abandoned due to

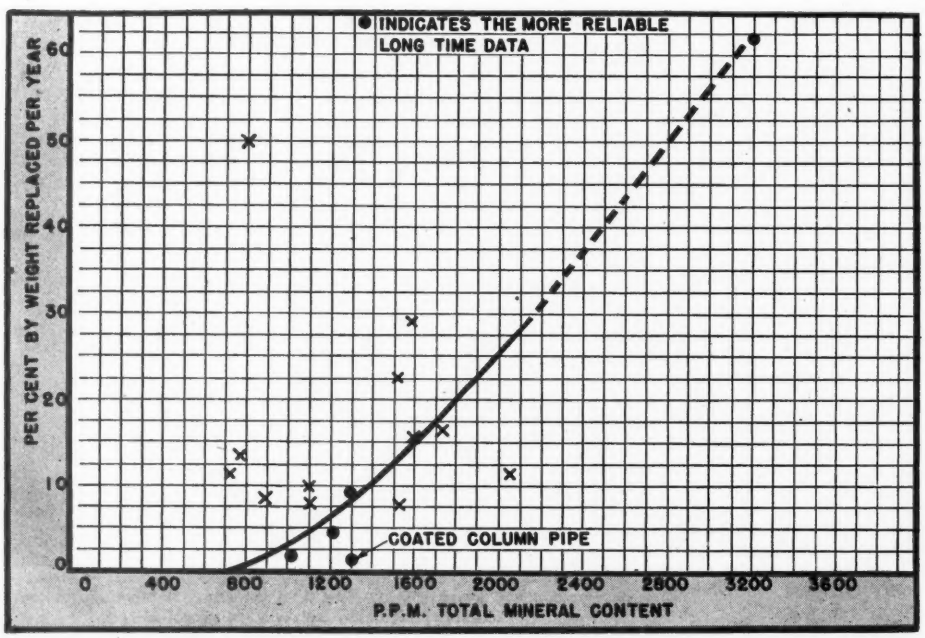

Fig. 1. This chart indicates the effect of water quality on galvanic action and also on general corrosion which may result from contact of mineralized water with any piece of steel or cast iron

corrosion, two due to sand erosion, one due to obsolescence and one was apparently as good as new. These pumps had been removed from wells geographically distributed over the midwest. This would indicate that the pump corrosion problem is not local.

In order that some confusion be removed from the question of corrosion of pumps, it is desirable to distinguish and recognize some four different types of attack. These four types are distinct and separate from mechanical erosion.

Corrosion Due to Galvanic Action

Galvanic action is recognized by the concentrated corrosion of one metal in contact with and in close proximity to another. Who has not seen the pitting that takes place on the exposed common steel shaft between two bronze impellers? A knowledge of the metals and alloys used in the construction of the pump is helpful in determining whether galvanic action could take place or not and therefore constitute a possible cause for the observed attack.

The rate of galvanic attack is in proportion to the relative exposed area of the cathodic metal to the exposed anodic area. It is also in proportion to the conductivity of the water which in turn is dependent on the total mineral content of the water.

Chart (Fig. 1) indicates the effect of water quality on galvanic action and also on general corrosion as may result from contact of mineralized water with any piece of steel or cast iron. Since the original publication of this curve nearly all of the points greatly distant from the curve have been explained by stray currents or by a high gas content.

One effect of dissolved oxygen is to decrease polarization or to increase the potential difference of the force driving galvanic current from the anode to the cathode. In other cases particularly with some hard waters it is recognized that dissolved oxygen can help to reduce corrosion by assisting in maintaining both a calcium carbonate and iron oxide film or coating.

Increasing the relative velocity between the water and the metal by increasing the motor speed is generally believed to cause an increase in the corrosion rate. It is again recognized that under specific conditions of protective action (polarization) the reverse condition may exist. It has often been demonstrated that an idle pump corrodes faster than one in use. The use of bronze bowls with bronze impellers eliminates the possibility of galvanic action between impellers and bowls.

Galvanic action can also be enhanced by a situation where two galvanic cells are set up in series in the installation. Such a situation exists where bronze impellers are used with cast-iron bowls and at the same time copper-alloy bearing-retainers are used with a water lubricated steel shaft or in the instance of oil lubricated pumps where bronze impellers are used with cast-iron bowls and water is permitted to enter the inclosure tube above the bowls and in contact with the bronze bearings and steel shaft.

It is obvious in these cases that current will flow from the iron impeller seats through the water to the bronze impellers and up the shaft to the bearings where it will leave the shaft through the water to the bearing retainers or to the bearings and down the column pipe or the inclosure tube to the bowls.—A vicious cycle. It would be difficult to reverse one of the cells to exactly counteract the other and without inaugurating a concentrated attack at another point.

There is considerable room for argument when any discussion on galvanic action takes place. Although the fundamental theories have been pretty well developed, the practical application of these theories is often obscure and requires considerable experimentation on the actual finished product.

Water line corrosion is also common and due to the existence of what is commonly called the oxygen concentration cell. It is adequately described in many textbooks. The obvious simple remedy is paint or some other good protective coating.

When CO_2 Causes Corrosion

Carbon dioxide corrosion is that which takes place at the high pressure points in the pump bowls and inside the column pipe and outside the shaft tube. Cavitation is distinguished from this corrosion by the fact that it takes place at the low pressure points on the impellers. This carbon dioxide corrosion is recognized by the occurrence of noticeable pitting at certain points on the guide vanes in the bowls and in the column pipe and on the shaft tube particularly just above the bowls and to a lesser extent just above the spiders.

It may be suggested that this is caused by the release of gas bubbles in the water at low pressure points on the underside of the impellers and possibly at the entrance to the suction pipe. This can happen particularly if rough edges are present. These gas bubbles are composed of nitrogen, water vapor and carbon dioxide and can be expected to form in any

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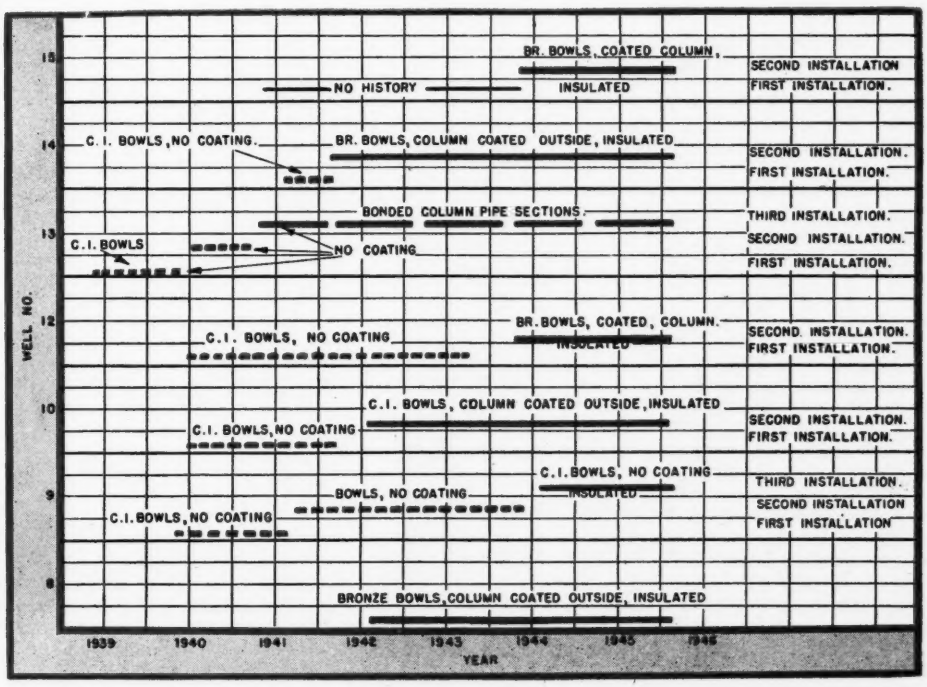

Fig. 2. The chart at the right shows the history of pump replacements in seven wells used by an industry whose property is overrun by stray currents from their operating machinery

A New Protective Device for the Series Capacitor

By R. E. MARBURY and J. B. OWENS Westinghouse Electric Corporation, East Pittsburgh, Pa.

A CAPACITOR connected in series with an electrical circuit improves its voltage regulation by inserting a negative reactance which in effect cancels all or part of the inductive reactance of the circuit. Such a capacitor is called a Series Capacitor. A Series Capacitor Installation consists of a bank of capacitors connected in series with each phase of a transmission or distribution line, each bank having the reactance necessary to cancel the desired portion of the phase reactance and designed to handle the maximum continuous and momentary line currents.

Capacitors may be subjected for brief periods to twice their rated voltage without damage to the dielectric; therefore, series capacitors may be allowed to handle momentary currents which are twice their continuous current rating. However, in most circuits to which series capacitors are applied the currents which flow during fault conditions are considerably more than twice the maximum working current. For this reason it is necessary either to use capacitors with a continuous current rating equal to one-half the maximum current which may flow during a fault or to use a voltage limiting device.

For a given reactance the cost of capacitors increases approximately as the square of the rated voltage so that it is usually much more economical to use capacitors whose rating is based on the working current and limit the voltage which can appear across their terminals by means of auxiliary apparatus.

Protective Gaps

The device used to protect a series capacitor during fault conditions must not allow the capacitor voltage to rise above twice the rated value even for a short time. Thus, it must function to by-pass the capacitor during the first half cycle of fault current. A gap is the only device which effectively meets this requirement.

The fundamental protected series capacitor circuit consists of a series capacitor shunted with a gap. If, however, this is a metallic gap which has a high arc voltage and a restriking arc, the series capacitor will be subjected to high currents while the arc exists in the gap. Figure 1 shows an oscillogram made of the current in a 33 ohm, 60 cycle series capacitor with a shunt gap set to break down at 3000 v. The gap electrodes were made of brass. The normal current of 43 amp was increased to 100 amp. The oscillogram shows the presence of high currents in the capacitor after the gap breakdown occurred. Such high currents cause heating of the capacitor and may cause serious damage.

The use of a gap having special graphite electrodes gives a low arc voltage and limits the current flowing in the series capacitor leads to a low value. Even with graphite electrodes, however, the arc will be moved out of the space between the electrodes by magnetic forces, thermal air currents, and random air currents unless special precautions are taken in the gap design.

Figure 2 shows the cross section of a special type of gap the authors have developed to insure a stable arc with a low arc voltage. The arc occurs between the surfaces A and B and is shielded from air currents by the upper electrode. Magnetic forces produced by the current traveling radially through the upper electrode are in such a direction as to keep the arc in the gap. Gaps of this design have been tested at currents up to 5000 amp for one second and sustained no damage. The arc remained between the gap faces at all currents, and there was no tendency for the arc to wander down the sides of the lower electrode. Figure 3 shows the results of a test using this new gap on the same circuit as that used for Fig. 1.

As the spacing of a gap is decreased, the variation in breakdown voltage on successive operations becomes greater. For dependable operation a gap should be adjusted to break down at not less than 3000 v. Since the gap must function dependably at no more than twice the rated capacitor voltage, it cannot be used to protect a capacitor rated at less than 1500 v unless an auxiliary means is provided to ionize the gap when the capacitor voltage reaches twice the rated value.

Figure 4 shows a diagram of a gap-protected capacitor with a continuous voltage rating of less than 1500 v. A step-up autotransformer is used to

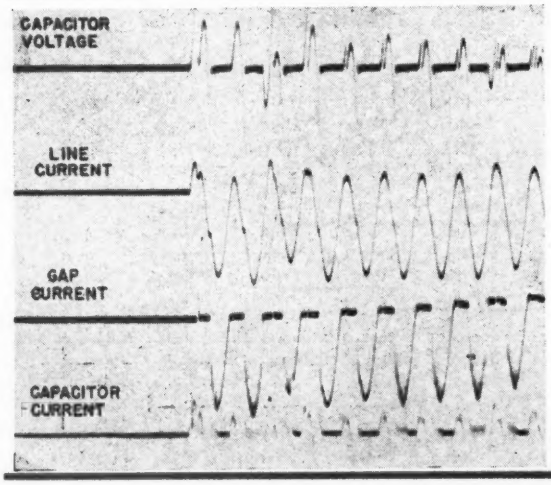

Fig. 1, left: Oscillogram showing operation of a conventional gap protecting a 33 ohm, 60 cycle, 1410 v series capacitor on a 100 amp fault

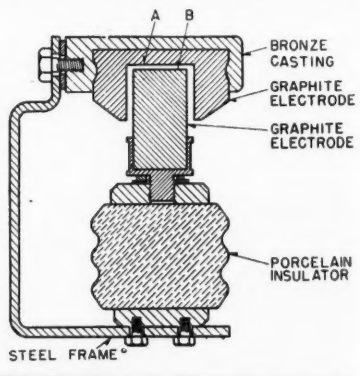

Fig. 2, right: Cross section of a new gap

New device described in this paper by the authors before the American Institute of Electrical Engineers provides superior protection of series capacitors from high voltage surges. The equipment involves a new type of arc gap and a thermally operated by-pass switch for automatically by-passing the gap and the series-capacitor and for removing the by-pass after the fault has entirely cleared

increase a voltage obtained across the series capacitor to a level such that the auxiliary gap will break down when the voltage on the series capacitor is twice the rated value. The breakdown of the auxiliary gap allows the small auxiliary capacitor to discharge into a raido frequency choke which is in series with the main power gap. This discharge causes a high frequency voltage to appear across the choke. Since the series capacitor has a low impedance at this frequency, the voltage appears across the power gap causing it to break down and pass power current.

A simple gap-protected series capacitor is a satisfactory installation provided no fault is of sufficient duration that the heat generated by the arc will damage the gap and provided the arc in the gap will go out when the line current drops to normal. Such conditions may exist on low voltage circuits. Usually, however, some special means must be employed to extinguish the arc in the gap.

Magnetic Contactors for By-Passing

Series capacitor protective devices made in the past have utilized gap current to initiate the closing of a magnetic contactor which by-passes the capacitor and gap to extinguish the arc. Such an arrangement is shown in Fig. 5. The capacitor closing coil is placed in series with the gap so that when the gap breaks down the current flowing through the gap will cause the contactor to close. The contacts are connected to shunt the gap and all but a small portion of the closing coil. The number of turns remaining in the circuit is sufficient to cause the contacts to remain closed until the current in the line drops to normal. Thus, the arc exists in the gap only for the time required for the contactor to close, and the contactor shunts the capacitor for the duration of the fault.

The magnetic contactor provides adequate protection of the gap in a gap-protected series capacitor; however, a special and expensive contactor must be designed and built for each application. The size of the operating coil must be adjusted for each equipment so that the contactor will pick up at twice the rated capacitor current and drop out when the current drops to the rated value. The coil must be designed to withstand the steep wave front surge imposed upon it when the gap breaks down and the stored energy of the capacitor is discharged into the coil. In addition to stressing the coil, this surge also causes the contactor to accelerate very rapidly so that its contacts are closed while the capacitor discharge current is still high. This imposes severe duty on the contacts, and they must be carefully designed to prevent welding or excessive burning.

New By-Passing Switch

To overcome the difficulties encountered in the use of magnetic contactors, the authors set about to design a new type of by-pass switch to meet the following requirements:

1. It must close rapidly enough to protect the gap from overheating during any fault up to 2500 amp.
2. It should have sufficient time delay on closing in order that any capacitor bank up to 180 kva at 230 to 2400 v would be substantially discharged through the gap before the contacts engaged.
3. The motor element must not be damaged by the maximum combined fault current and capacitor discharge current.
4. It must have sufficient time delay on opening to allow a fault to be cleared by the line breakers so that no holding arrangement is required.

The switch developed for this purpose is a thermally actuated toggle switch which has quick-make and quick-break action and is connected as shown in Figure 6. The bellows is evacuated and charged with a small quantity of a liquid having a low vapor pressure at any ambient temperature which may be encountered in service. At such temperature the bellows remains collapsed because of external atmospheric pressure. When mounted in the switch, it is stretched

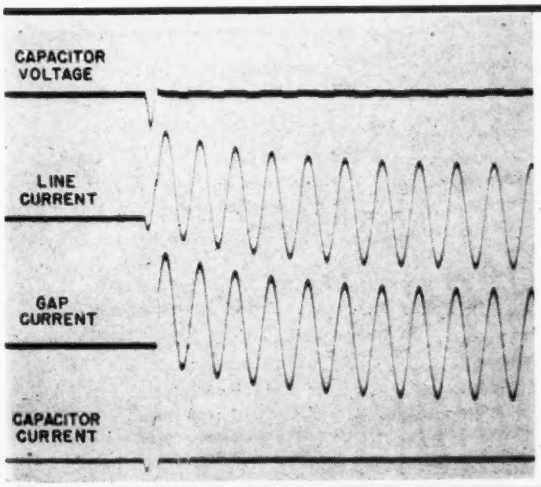

Fig. 3, left: Oscillogram showing operation of new gap protecting a 33 ohm, 60 cycle, 1410 v series capacitor on a 100 amp fault

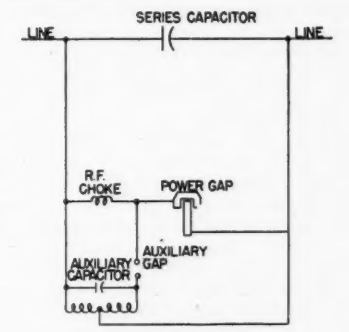

Fig. 4, right above: Series capacitor protective device for low voltage capacitors

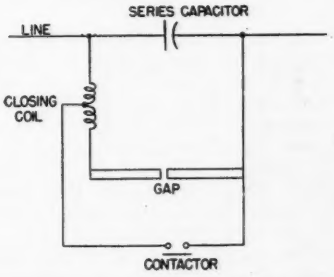

Fig. 5, right below: Series capacitor protective device with magnetic contactor to extinguish arc in gap

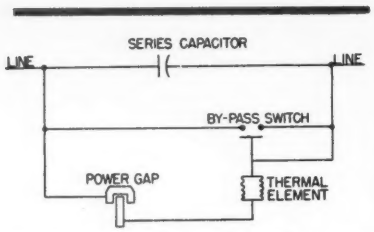

Fig. 6. Series capacitor protective device using thermal switch

to the normal length and exerts a pull more than sufficient to open the switch mechanism. When gap current passes through the walls of the bellows, heating occurs which changes the vapor pressure of the enclosed liquid. Continued heating causes the vapor to exert a pressure sufficient to actuate the toggle mechanism causing the switch to close. Figure 7 is an oscillogram showing the gap and switch operation in protecting a 16 ohm, 60 cycle series capacitor during a 2000 amp fault.

Results of Cooling

The closing of the switch by-passes the entire series capacitor and thus terminates the flow of gap current and allows the bellows to start cooling. Cooling causes the vapor to recondense, and the resulting differential pressure reopens the switch and restores the series capacitor to service.

The gap may be allowed to reach a temperature of 250 C with no risk of damage. Figure 8 shows the time-current characteristics of the gap shown in Fig. 2 based on an attained temperature of 250 C on the top casting and also shows the time required for the switch to close for the same currents. From this it is seen that the switch meets the first requirement of protecting the gap for all currents in the operating range. The tests from which these data were procured were made at an ambient of 25 C, however, the gap and switch combination is temperature compensating, and adequate protection is obtained throughout the operating temperature range. At high ambient temperatures the gap reaches the maximum permissible temperature in a shorter time, but the switch closes more rapidly. At low ambients the switch operates more slowly, but the gap requires longer to reach the temperature limit. Temperatures below the freezing point of the enclosed liquid do not damage the bellows because of its flexible nature and because the quantity of liquid is very small. Operations at ambients below freezing do not take appreciably longer than those above freezing since the heat of fusion of the liquid is small compared to the total heat input required to raise the bellows to the operating temperature.

The motor element in the new switch is essentially self-protecting since the switch operates to stop the current flow in the bellows when it reaches a certain temperature. High currents simply cause the switch to operate more quickly. The switch shown has been tested with fault currents of 2500 amp and capacitor discharge currents of 100,000 amp and sustained no damage.

The opening time of the switch varies from two to five minutes over the ambient temperature range of —20 C to +50 C. Thus any fault will be cleared by the line breaker before the switch opens to restore the capacitor to service. An arcing ground on the system cannot cause operation of the switch more often than once every two minutes so that heating in capacitor caused by discharge through the gap cannot be cumulative and cause damage.

Method of Installation

Figure 6 is the diagram of a high voltage (above 1500 v) series capacitor with short circuit protection. Figure 9 shows the low voltage equipment. In either case the complete assembly of equipment for each phase is mounted on a platform which is insulated from ground for the line-to-ground voltage. Outdoor type capacitor units are used, and the protective equipment is housed in a weatherproof steel housing with one entrance bushing. A stud on the housing serves as the other terminal. Disconnect switches are provided to by-pass and isolate the capacitor for inspection and maintenance.

Operating Limits

During momentary overloads, such as might be caused by motor starting or the operation of a resistance welding machine, the series capacitor rated current may be exceeded, and it is not intended that the short circuit protective device should operate at such times. The breakdown voltage of the protective gap is subject to variation with temperature, humidity, condition of electrode surfaces, and rate of rise of the applied voltage. To allow for these variations, the gap is set to positively break down at 200 per cent of the rated voltages and never to break down at 150 per cent of the rated voltage. Therefore, it is important that the momentary current peaks never exceed 150 per cent of the continuous current rating of the capacitor. In some cases the current peaks will considerably exceed the normal sustained current. In these cases it is necessary to use a capacitor with a sufficiently high current rating that it will never be exceeded by more than 50 per cent even though the capacitor will run most of the time with less than rated current.

Other Types of Protection

A series capacitor will be damaged by continuous operation at more than 110 per cent of its rated current. The short circuit protective device may not function at less than 200 per cent of rated current; therefore, it is sometimes desirable to provide overload as well as short circuit protection. The overload protective device should have an inverse time-current characteristic which can be coordinated with that of the capacitor to allow momentary but not continuous overloads. The bellows operated switch is ideal for this purpose. It is only necessary to connect a bellows of the proper current rating in series with the capacitor and to connect the switch to shunt the capacitor and bellows.

Dielectric Failure Protection

Still another type of protection that is sometimes used for series capacitors is dielectric failure protection. This is a means of detecting a failure in the working insulation of a capacitor unit in a capacitor assembly. In an unfused capacitor bank a short circuited capacitor unit may sustain an internal arc which will cause gas to be generated in the unit. Continued operation will cause the pres-

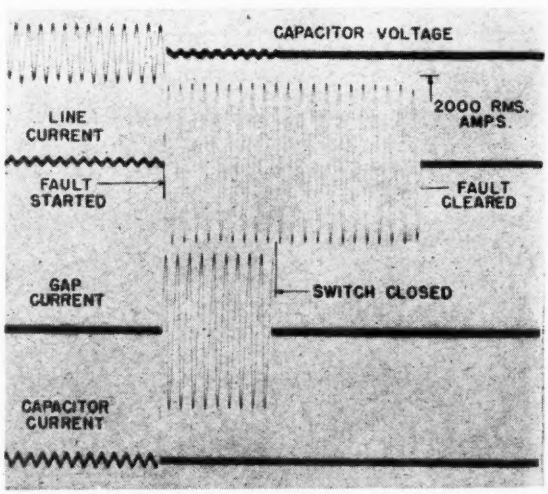

Fig. 7. Operation of series capacitor protector using bellows operated switch

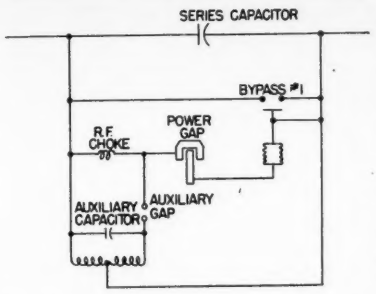

Fig. 9. Low voltage series capacitor protective device

sure to reach a value which will rupture the case and possibly cause damage to other units and equipment. If the units are equipped with individual fuses, a fuse operation to remove a faulty unit increases the reactance of the bank and continued operation at the rated current of the original bank will subject the remaining units to overvoltage. The by-pass switch used in a protective device for dielectric failure protection is a spring biased to the closed position and latched in the open position. A magnetic device is used to trip the latch when the currents become unequal in two equal branches of the capacitor bank. Each phase of the series capacitor bank is divided into two equal branches through one winding of a special current transformer. No voltage is induced in the secondary winding until the two currents become unequal as a result of the short circuit in one of the capacitor units or a removal of one or more units bu operation of individual fuses.

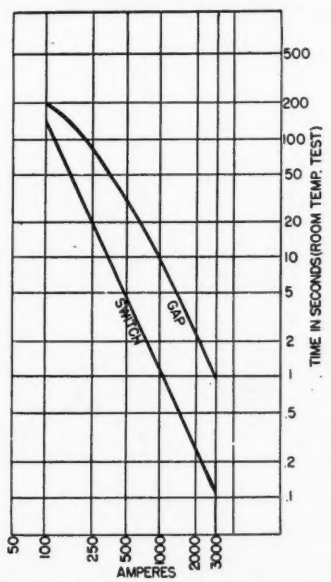

Fig. 8. Time-current characteristics of gap and switch

SCIENCE'S WATERLOO?

(Continued from page 69)

possible to determine the extent of duplication or the number of ideas that have stagnated until the scientific documents and publications of the nation are analyzed.

At the Naval Ordnance Laboratory we have attempted to analyze a portion of the data compiled during the war years. The difficulties encountered have been almost insurmountable. **The major problem has been that of finding suitable technical personnel of the right calibre and temperament to tackle this kind of job.** In general, trained scientists do not like desk work, as they feel research belongs more to the laboratory than the library. Secondly the nomenclature now being used in modern science is extremely complex and confusing. The terms found are clear only to those intimately associated with a specialized field, but the choice of suitable subject headings causes the real headache.

Missing an Enormous Amount

Scientific documents are being published today at a rate that not one scientist in fifty fully appreciates. This does not imply that scientists are negligent, but for security reasons and because of inadequate library facilities, they consequently remain unaware of the existence of these documents. In our library we have, in addition to our books, some 22,000 documents, many of which are extremely important. We feel that we have done a fairly good job of collecting considering the length of time that we have been organized. But we—like every scientific library—are missing an enormous amount of material which will be regretted bitterly in the future.

Scientific libraries are in an extremely bad position today. Our sins of not completely cataloging information as it has come to us are catching up with us. Even now we operate at least 75 per cent from memory, and when our memory fails, we will be in an infinitely worse condition. If we forget about Strong's book containing data on glassblowing, we may expect never to find it again.

Do We Want Progress?

Science continues to progress, but how long can it endure when many of the basic concepts are being buried? If immediate action is not taken, devices will be invented, and before they are even completed—if the reports describing them are turned over to the customary files—the details will be swallowed up, never again to be found until a slow page by page search is made. Time and again we are asked for reports or documents "about an inch thick with a blue cover that has a chapter showing a phanotron circuit." The scientist has forgotten the title, but a basic idea is buried in the report. What are we to do?

First of all we must ask ourselves whether or not we want science to continue to progress at the rate it has in the past twenty years. If so, we must do something about the analysis of scientific information.

Librarians Must Have Scientific Knowledge

This starts with colleges and universities. **Facilities and courses for training technical librarians must be established in the schools of the country. Librarians must become more than very well versed in the basic fundamental sciences such as physics, mathematics, chemistry, and biology. They must also be trained in library service. There are many technical librarians who today are familiar with thousands of scientific words, but do not have the slightest idea as to their meaning. Librarians, to work in the scientific field, must have a basic knowledge of science.** Further, technical librarians must be trained in sufficient quantity to do the job, which means that we must encourage students to pursue this vocation.

Next, science itself must adopt a basic scientific language. There is no reason why an identical item should be known under fifteen different names, as is now the case.

And last of all, the time inevitably must come when we go back and analyze the scientific literature accumulated through the years. Covered with an accumulation of dust are books published in the middle 1700's that describe ideas that could be headlines, five years from now.

If these things are done, science can continue to progress; if we do not act, science will also continue to progress up to a certain point, but a stalemate is sure to follow. That time is not too far away. We must act now. The very foundations of science are in dire jeopardy when a condition exists which permits the loss of fundamental concepts.

ELECTRICAL EXPOSITION GAINS HEADWAY

Strong interest and substantial support rapidly developed following announcement of the Electrical Engineering Exposition, to be held in New York, January 27-31 next, concurrently with the Winter Convention of the American Institute of Electrical Engineers.

The Exposition will assemble under one roof the newest developments in electrical equipment for the generation, transmission, distribution and utilization of electrical energy. It is designed to be of special benefit to engineers and operating men who are responsible for the design, construction and operation of large electrical installations, including light and power company engineers, engineers associated with electrified railroad operations, operators of large industrial plants with major electrification problems, communications as related to telephone and telegraph lines, consulting engineers and executives interested in the construction and management of electrical properties.

Modernizing the Coal-Handling Control at Philo—II

By **A. H. BEILER** Electrical Engineering Division, American Gas & Electric Service Corp.

WITH THE INSTALLATION of the two 100,000-kw turbo-generators, the original coal handling capacity of 500 tons of coal per hour was increased to 750 tons per hour. Additional conveyors were added to provide a number of alternate sources of the coal supply, crusher capacity was increased and conveyors added over the new bunkers in the station. A car dumper was installed which bodily inverts a railroad coal car and dumps its contents into a hopper.

Enlarged Facilities

Figure 3 (repeated from Part I, August issue) is a diagrammatic layout of the present system. Coal takes the following route to the plant:

Coal Feeders 1AF and 1BF, Conveyors 1, 2, 3, 4, 5, 7, 9 and 10. Inside the plant a coal tripper on Conveyor 10 intercepts this coal to deposit it on Conveyors 11, 12, 13, or 14. (All the older conveyors were renumbered when the additional facilities were installed.) Conveyor 14 deposits the coal onto traveling Conveyor 15 which distributes it to the bunkers supplying the boilers for the two 100,000-kw turbo-generators. Conveyors 11, 12, and 13 and the associated coal trippers deposit coal into the bunkers supplying the older boilers. Conveyors 10, 12 and 13 have motorized coal trippers; that for Conveyor 11 is operated mechanically from the belt itself.

Screw Feeders 2AF and 2BF take the coal from the car dumper hopper and deposit it onto Conveyor 2.

Another supply of coal arrives over the two pan conveyors PCW1 and PCW2 receiving coal from a track hopper by means of screw feeders PCW1F and PCW2F.

Coal can be taken from still another track hopper by Feeders 8AF and 8BF to Conveyor 8 and thence on to Conveyor 9 and so into the plant.

A number of coal screens, crushers and magnetic pulleys condition the coal en route so as to make it suitable for reception by the pulverizer mills.

A number of conveyors were motorized on the gantry crane. Previously the tripper which intercepted the coal from Conveyor 7 for dumping to storage deposited the coal on to a cross conveyor, 6, mechanically driven by Conveyor 7 (originally called Conveyor 1). This cross conveyor was reversible so that coal could be taken away from the northbound Conveyor No. 7 to either an eastern or western storage pile. The dumped coal thus formed two cones with their apexes under the ends of the cross conveyor. By shortening this conveyor and mounting it on a movable carriage, the discharge point could be moved over the entire transverse distance to form what were in effect an infinite number of cones, thus making it unnecessary to enlist other facilities to smooth out the storage piles. A reversible 7½ hp dc motor was installed to drive Conveyor 6 and a 3 hp motor to drive its carriage.

The coal from storage is reclaimed by two buckets which dump it via a hopper onto two pan conveyors moving towards each other, and depositing their contents on to Conveyor 7 for delivery to the plant. These two pan conveyors were also originally driven by Conveyor 7 but were now motorized with two 15 hp dc motors in order to avoid the use of cumbersome mechanical interconnections.

Increased Power Supply Required

All these additions required a corresponding increase in the power supply. The two 2300-440-v transformers, which in 1928 had been increased from a capacity of 450 to 750 kva, were now further increased to 1500 kva per bank. This required rebuilding of the 2300 and 440-v connections at the transformers and at the 440-v bus. A main 440-v feeder was run to

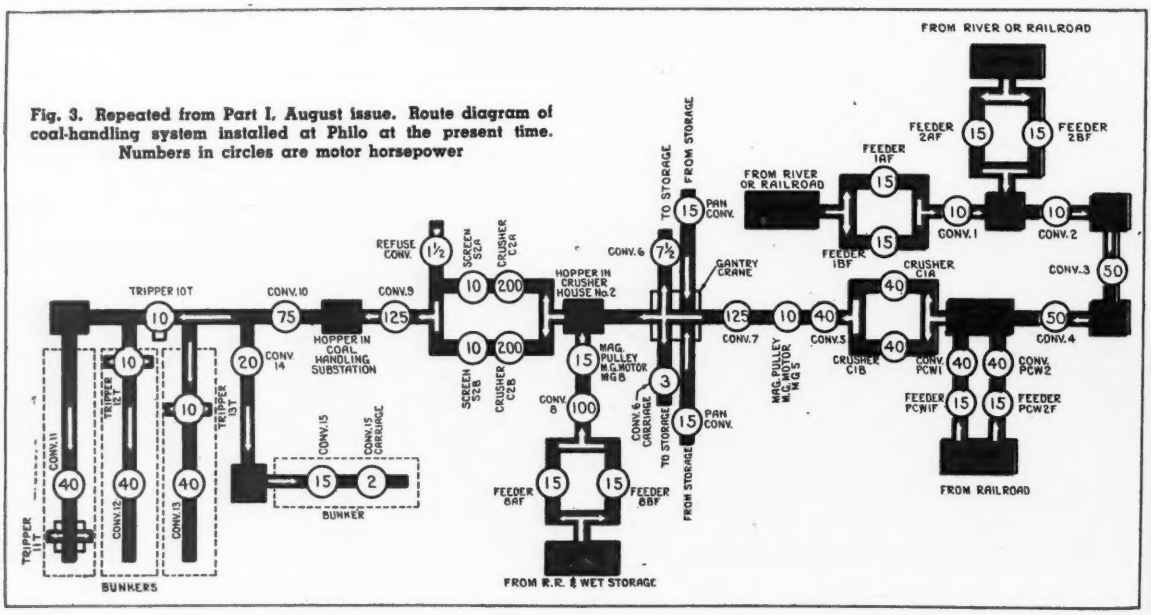

Fig. 3. Repeated from Part I, August issue. Route diagram of coal-handling system installed at Philo at the present time. Numbers in circles are motor horsepower

While the capacity of the Philo Station of Ohio Power Co. was being increased 5-fold—from 80,000 kw in 1924 to over 440,000 kw in 1943—the coal-handling system and its control also had to be modernized to keep pace . . . Part I in the August issue described in detail the original control system, the last word in its time . . . It controlled automatically 10 conveyor and crusher motors and other equipment and occupied four sides of the control room. Part II herewith describes in detail the operation of the very compact and effective coal-handling system, installed at present using modern steel-enclosed contactors and circuit breakers instead of the former open panels. In a quarter of the space it controls 32 motors and provides all the automatic sequence and protective operations desired . . . Sequence of automatic starting and operation of each item explained.

the south end of the plant where most of the new conveyor motors were concentrated.

The gaping wounds left in the old control panels, the open contactors, battle-scarred from years of service, and the increased importance of the coal handling facilities in so large a plant, finally led to the decision that it would be wiser to replace this hazardous equipment by modern steel-enclosed, electrically-operated air circuit breakers and combination across-the-line magnetic starters and manually-operated air circuit breakers. These last are particularly convenient for motor control and are priced attractively because of quantity production by many of the large control manufacturers.

In the original design there was no adequate short-circuit protection in case of 440-v bus or feeder trouble. It was necessary to open the 2300-v transformer breaker to clear a 440-v short circuit. There had been rumors, probably exaggerated, that during times when a crusher "plugged up," its primary contactor jumped off the panel and did wilfully and with malice aforethought threaten bodily injury to the attendant; therefore remedial measures were clearly indicated. By installing combination circuit breakers and magnetic starters, each pair in its own safety enclosure, protection could be obtained against motor overload, feeder short circuit, and damage to personnel. The circuit breaker also served as a convenient disconnecting device for the contactor.

Modern Circuit Breakers

For ratings in excess of about 100 hp and for moderate short-circuit duty, it is more economical to install an electrically-operated circuit breaker than a combination magnetic switch and manually-operated air circuit breaker and this was done at Philo for the large motors. Assurances were received from the circuit breaker manufacturer that his devices would stand up under the fairly frequent service required in conveyor opera-

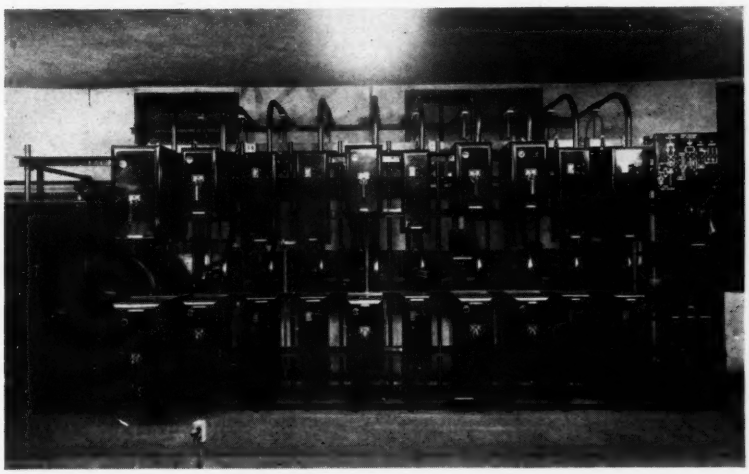

Fig. 4. Repeated from Part I, August issue. Coal-handling control equipment now in operation at Philo Station. The steel-enclosed contactors and circuit breakers directly control 20 motors and indirectly control 12 additional motors. Note route diagram on master panel at upper right. Compare with Fig. 1, Part I, August issue

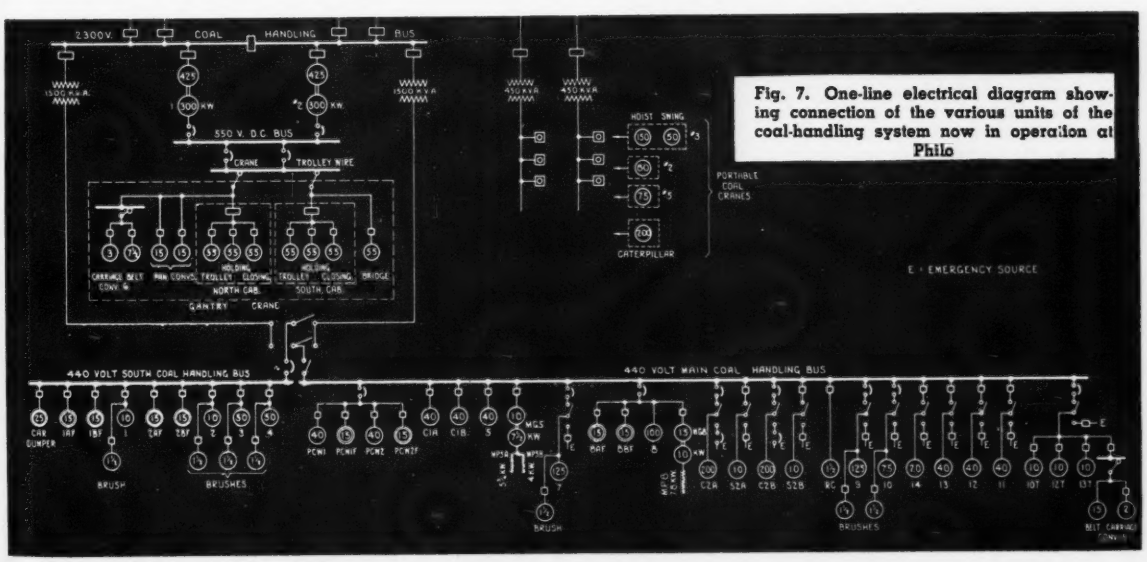

Fig. 7. One-line electrical diagram showing connection of the various units of the coal-handling system now in operation at Philo

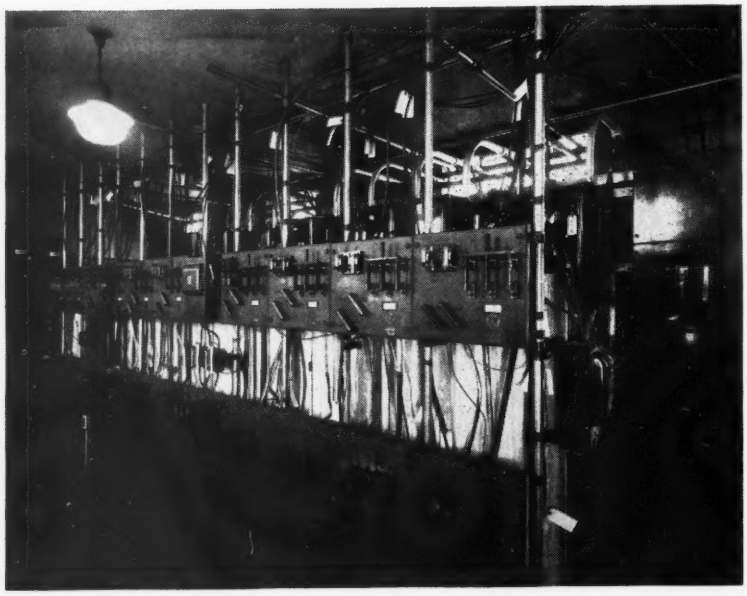

Fig. 8. View of the construction work during the transition from open to enclosed panels

tion. Experience confirmed this. There has been no excessive maintenance when operating the electrically-operated circuit breakers on the average of ten times per day.

These circuit breakers have the usual dual overload features for short circuit and overload protection. A slight disadvantage in their use was the fact that both of these overload attachments are mechanically direct-acting to trip the circuit breaker, whereas, for sequence interlocking, it is frequently desirable that the overload devices open an electrical control circuit. Where such operation was absolutely necessary, additional temperature overload relays with circuit opening contacts were used, and the corresponding device in the circuit breaker made inoperative.

Construction of New Control System

The photograph, Fig. 8, was taken during the transition from the old, open slate panels to the new enclosed gear and Fig. 4 shows the finally-assembled control. The eight motors for conveyors 1 to 4 have their control contactors mounted near the south end of the conveying system which is over 1300 ft from the equipment shown in Fig. 4. The route diagram is clearly indicated on the upper section of the master panel on the extreme right.

The main control switch, which was originally an open knife switch, has been replaced by a safety switch, the various by-pass knife switches have been replaced by modern switchboard type control switches, and standard switchboard auxiliary relays are used for the master devices. Two of the geared motor timing relays used with the new control scheme can be seen on the bottom section of the master panel. The long boxes enclose combination air circuit breakers and magnetic switches, the shorter ones are electrically operated air circuit breakers. The two large boxes second from the left are manually-operated feeder breakers to control motor groups and the large box on the extreme left houses a T.P.D.T. switch for selecting the main and emergency supply to the south coal handling circuit. (See one-line diagram, Fig. 7.) The two circuit breakers in the fourth column from the right have supplementary temperature overload relays underneath them for the additional interlocking described previously. A wiring trough at the rear of the supporting structure carries the control and interlock wires.

The compactness of this assembly carrying the switchgear of 18 motors or motor groups and controlling a total of 32 motors is to be compared with Fig. 1, where twenty 90-in. high panels, extending along two sides of the room and occupying a space over 34 ft long, were used to control 10 motors.

How the Present System Works

Figure 9 is an elementary diagram of the new automatic control system. It appears more complicated than the original system because it shows the control of 32 motors instead of 10; also Fig. 6 (Part I, August issue) omitted all primary and accelerating contractor coils; whereas, Fig. 9 shows all the primary contactor coils. There are, of course, no accelerating contactors in the new system.

When the control system was changed, it was found that the practically simultaneous closing of all the contactors, even though they operated in sequence, sometimes drew so large a starting current as to open the 2300-v transformer breaker. This was particularly evident when starting after an emergency shut-down with the conveyors carrying coal and the crushers full. To avoid this, several timing relays were used to delay various sections of the sequence from starting until either the conveyor belt or crusher had cleared itself of coal or the starting current on a number of motors had decreased to normal running current.

Present Automatic Sequence Control

Referring to Fig. 9, pressing the "Start" push button energizes master relays C1X and C2X, if the route selector switch is in the "Entire System" position, all emergency push buttons at the crusher are closed and the overload relays for the four crushers, C1A, C1B, C2A, C2B and the two screens, S2A and S2B, have their contacts closed. If all the belt emergency push buttons are also closed, two geared timing relays, "Conveyor 7 Timer" and "Cross-Belt Timer," will start timing.

The closing of master relay, C1X, starts crusher motors C1A and C1B provided crusher by-pass switch, "CH1" is in the "Normal" position. Similarly the closing of the master relay, C2X starts screen motors, S2A and S2B provided the crusher by-pass switch "CH2" is in the "Normal" position. As soon as the screens start, the respective crusher motors, C2A and C2B, start. The starting of these six motors takes place almost instantly.

A small refuse conveyor starts immediately when either crusher C2A or C2B starts. It carries away from the conveying system refuse such as shale and slate rejected by the coal screens. It is not interlocked in any other way with the remainder of the system.

As soon as either of the two crusher motors, C2A or C2B starts, interlocks on their contactors apply L-1 potential to cross-belt auxiliary relay, CBX. This can also occur immediately that master relay C2X closes, provided that the crusher by-pass switch "CH2" is in the "by-pass" position. Relay CBX does not close, however, until the cross-belt timer, "CBT" has finished timing. This delay is to insure that the crusher motors have cleared themselves of coal before any conveyor motors start to deliver an additional supply to them.

Operation of Conveyors

When the cross-belt timer has completed its timing, it closes its contact and the cross-belt auxiliary relay, CBX, closes, provided the overload relays for the 4 cross-belt motors, 11, 12, 13 and 14, are closed. These 4 cross-belts are individually controlled by push buttons operated by an attendant stationed near the conveyors who starts and stops them as required, but their starting is conditioned on the closing of the cross-belt auxiliary relay. At least one of these 4 cross-belts must be running before the starting sequence can proceed. Then Conveyor 10 starts, followed immediately by Conveyor 9.

At Conveyor 9, there is a solenoid-operated water valve to wet down coal which is to be routed to the older stoker-fired boilers. This valve will open automatically after Conveyor 9 starts and is carrying coal. Simply opening the valve when Conveyor 9 starts would cause unnecessary wetting of the conveyor belt when it was not carrying coal. To avoid this, a "paddle" switch is inserted in the solenoid circuit. The paddle is engaged by the piled coal on the belt and thus the valve is opened only when Conveyor 9 is actually moving coal.

Except for the fact that Conveyor 9 must be running, Conveyor 8, its two coal feeders, 8AF and 8BF, and its magnetic pulley MG set motor, MG8, operate independently of the rest of the system since this is a branch line. Conveyor 8 can be started from its own maintaining contact push button provided all emergency push buttons along its runway are in the closed position. It is necessary that Conveyor 9 be running to assure that the coal which Conveyor 8 delivers to Crusher House No. 2 will be taken away.

The magnetic pulley MG set motor and the two coal feeder motors receive their power supply from the load side of the circuit breaker which starts Conveyor 8. Therefore, as soon as Conveyor 8 starts, the magnetic pulley MP8 becomes excited.

The Conveyor 8 feeders, 8AF and 8BF, are driven by variable speed wound rotor motors operated from drum switches. After Conveyor 8 starts, the feeder motors can be started from these drum switches and operated at whatever speed is required for proper coal delivery. The drums have the standard auxiliary contacts so that in the first position a circuit is completed to close the primary contactor which then seals itself in. In subsequent positions, the drum switch no longer controls the primary contactor. This gives under-voltage protection since on loss of voltage the primary contactor opens and it is necessary to return the drum to the off-position to start the motor again.

Returning now from the branch conveyor, 8, to the main run, Conveyor 7 starts next. It depends on both Conveyor 9 and its own timer, "7T" in order to start. If Conveyor 9 is running and the timing relay has completed its operation, and with the route selector switch in the "Entire System" or "From Storage" positions, Conveyor 7 will start. This conveyor may be stopped manually by a "Scale Reading" switch. Turning the switch to the "Scale Reading" position stops the coal flow into Crusher House No. 2 and enables the operators to obtain an integrated scale reading of the amount of coal that has passed into the plant during a pre-determined time interval. As soon as the reading has been taken, the scale reading switch is again turned to normal and Conveyor 7 and all conveyors following in the sequence start again.

Operations to Store Coal

When coal is to go to storage, none of the equipment previously described, except crushers C1A and C1B and Conveyor 7 need be operated. The coal is taken off Conveyor 7 by the gantry crane and dumped into the yard. It must first be crushed, however, hence the two crushers C1A and C1B must be running. To obtain this routing, the route selector switch is placed in the "To Storage" position. This prevents relay C2X from becoming energized which in turn prevents the starting of the entire sequence up to Conveyor 7. However, relay C1X stays energized and enables crushers C1A and C1B to start.

The route selector switch in the "To Storage" position by-passes the Conveyor 9 interlock in the circuit of Conveyor 7 so that this latter conveyor is then dependent only on timing relay, 7T. Thus it can be seen that in the "To Storage" position of the route selector switch, crushers C1A and C1B start, and then, after Conveyor 7 Timer has completed its timing, Conveyor 7 starts, the balance of the system between Conveyor 11 and Conveyor 7 remaining inoperative.

Proceeding now with the normal

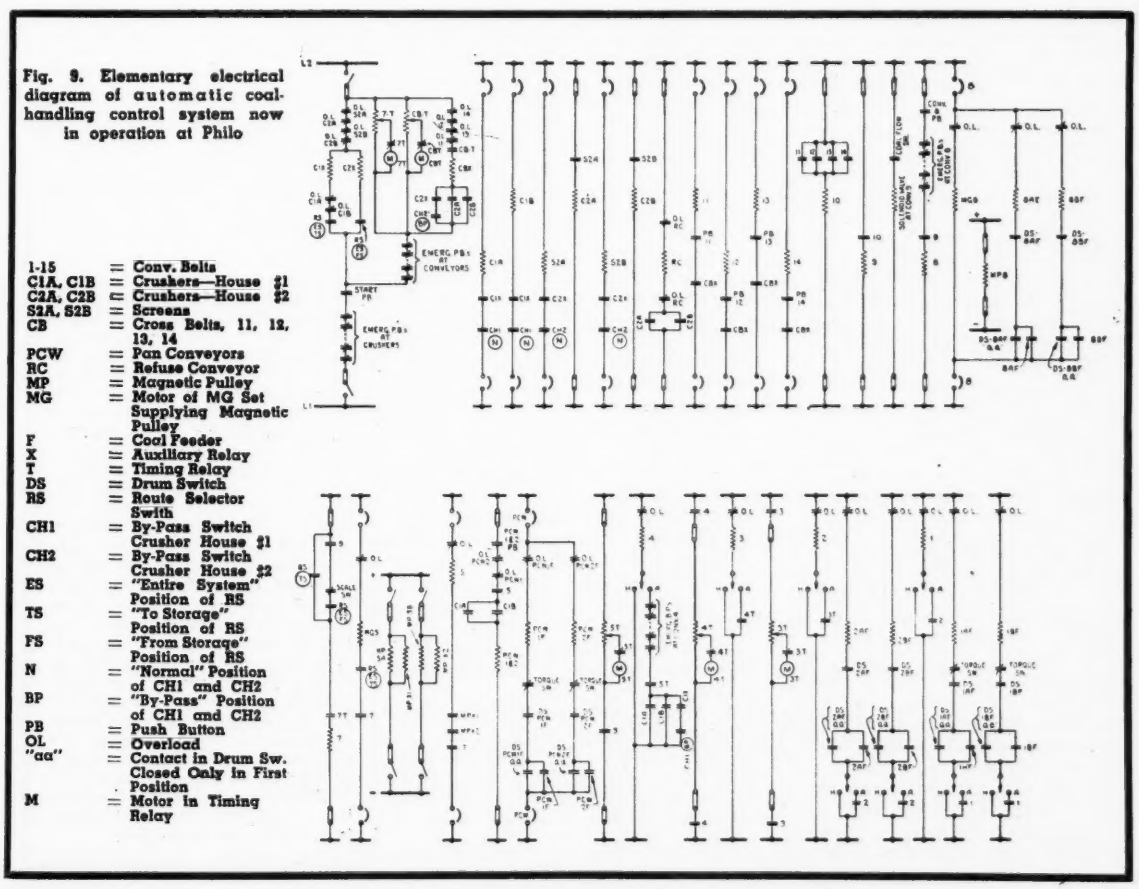

Fig. 9. Elementary electrical diagram of automatic coal-handling control system now in operation at Philo

1-15	=	Conv. Belts
C1A, C1B	=	Crushers—House #1
C2A, C2B	=	Crushers—House #2
S2A, S2B	=	Screens
CB	=	Cross Belts, 11, 12, 13, 14
PCW	=	Pan Conveyors
RC	=	Refuse Conveyor
MP	=	Magnetic Pulley
MG	=	Motor of MG Set Supplying Magnetic Pulley
F	=	Coal Feeder
X	=	Auxiliary Relay
T	=	Timing Relay
DS	=	Drum Switch
RS	=	Route Selector Swith
CH1	=	By-Pass Switch Crusher House #1
CH2	=	By-Pass Switch Crusher House #2
ES	=	"Entire System" Position of RS
TS	=	"To Storage" Position of RS
FS	=	"From Storage" Position of RS
N	=	"Normal" Position of CH1 and CH2
BP	=	"By-Pass" Position of CH1 and CH2
PB	=	Push Button
OL	=	Overload
"aa"	=	Contact in Drum Sw. Closed Only in First Position
M	=	Motor in Timing Relay

operation, when Conveyor 7 starts, it starts the magnetic pulley MG set motor, MG5. Its generator builds up a dc potential and excites the magnetic pulley MP5A and its auxiliary magnet MP5B and two under-voltage relays, MPX1 and MPX2 connected across their respective terminals. It is necessary that both of these relays are energized and that Conveyor 7 is running and then Conveyor 5 starts.

The two pan conveyor motors, PCW1 and PCW2, and their feeders, PCW1F and PCW2F, are controlled by a single circuit breaker. To close it requires that crushers C1A and C1B are running and that the overload relays of the two pan conveyor motors are in their normal position. It can then be closed from a push button. Besides starting the two pan conveyors, the closure of this circuit breaker enables the feeder motors to be started from their drum switches in a manner similar to that of Conveyor 8 feeders. The pan conveyor feeders however, have torque switches in their circuit so that overload due to jamming of coal can be protected against mechanically by these devices to supplement the electrical protection from the temperature overload relays.

The starting of Conveyor 5 also starts a timing relay, 5T, which when its timing is completed, and provided either crusher C1A and C1B is running, or both are by-passed, starts Conveyor 4. Conveyors 4, 3, 2 and 1 are provided with local "Hand-Off-Automatic" selector switches so that their motors can be started independently when so required. Conveyor 4 is also subject to control by a series of emergency push buttons situated along the conveyor runs at the "South End" of the coal handling system, the part which involves Conveyors 1 to 4. All the push buttons must be in their normal position before Conveyor 4 can start.

Simultaneously with the starting of Conveyor 4, another relay, 4T, begins timing, and after this operation is completed, it starts Conveyor 3. Conveyor 3 similarly starts Conveyor 2, and the latter in turn starts Conveyor 1 and also enables the two feeders 2AF and 2BF to be started from their drum switches. Finally Conveyor 1 enables its feeders 1AF and 1BF to be started by their drum switches. This completes the normal sequence starting of the system.

Withdrawing Coal from Storage

Operation for the "To Storage" condition has already been described; for operation "From Storage" all the conveyors following No. 7 in the sequence need not run. Turning the route selector switch to the "From Storage" position prevents the magnetic pulley MG set motor, MG5 from starting and hence Conveyor 5 and all following conveyors cannot start.

Turning the Crusher House No. 1 by-pass switch to its "By-Pass" position enables Conveyor 4 to start independently of the crushers, C1A and C1B. Similarly, turning the Crusher House No. 2 by-pass switch to its "By-Pass" position enables the cross belt auxiliary relay, CBX, to operate independently of crushers C2A and C2B, so that the cross belts may be started.

Miscellaneous Features

The motor-driven coal trippers, 10T, 12T and 13T operate independently of the automatic system. The motors are supplied from individual three phase trolleys. The reversing contactors and control push buttons are mounted on the tripper and are operated by an attendant who either rides the tripper or walks alongside it as it moves.

Across the terminals of each motor in the automatic sequence there is connected a red indicating light and these are mounted on a route diagram painted on the master panel. The operator can thus tell at all times which motors are in operation. A supplementary route diagram with lights is installed at the South End for the 8 motors there.

Trouble had occasionally been experienced from coal filling the various chutes and hoppers faster than it was taken away. To avoid this, paddle switches were installed so that when the coal rises to a predetermined height, the paddle switch closes its mercoid contact and energizes an auxiliary relay. Each auxiliary relay has two contacts, one to light a lamp and a second to energize a common alarm bus to operate a horn. This latter attracts the operator's attention and the lamp indicates at which chute or hopper the obstruction lies. Since the conveying system traverses considerable territory, several horns are used.

When the coal handling system was originally installed in 1924, some concern was felt about the reliability of the automatic control equipment and an emergency feeder was run to most of the motors, to which they could be connected by a T. P. D. T. switch whenever trouble developed at the control panels. Operation over the years demonstrated that this feature was not a necessity and the later additions do not have it.

Most of the conveyors have small brush cleaners whose function is to brush off any coal clinging to the under sides of the belts after the conveyors have deposited their coal into the assigned hoppers or chutes. They are driven by small 1½ hp motors and start and stop automatically with their respective conveyors. However, the brushes which are helically grooved rollers, have a tendency to clog and their use is being discontinued.

The coal feeders sometimes also clog and reversing switches are provided for their motors to correct this condition.

Most of the motors are controlled by contactors. Some of the larger ones are controlled by electrically operated air circuit breakers but these have under-voltage relays connected so that the closing of a contact closes the breaker and the opening of a contact opens it. Thus the breaker, although a latched device, operates like a contactor. This type of operation avoided sequence interlock complications. The details have been omitted from the elementary diagram.

Traveling Conveyor Control

The traveling conveyor, 15, has a novel control scheme previously described in the literature.* There are two motors, one to rotate the belt and a second to move the entire carriage of the conveyor from bunker to bunker. Both motors are on the moving carriage, thus necessitating trolley wires. Local conditions require that the carriage motor be operated from push buttons on the carriage while the conveyor motor be operated external to the carriage. Both motors have to be reversed independently of one another. To avoid the use of two 3-phase trolleys, an ingenious arrangement was worked out whereby a reversing contactor controlled the line to a single 3-phase trolley. A phase reversal relay and the reversing contactor and push buttons for the carriage motor were mounted on the carriage itself. Operating the push buttons external to the carriage to reverse the conveyor belt reversed only the belt motor because the tendency of the carriage motor to also reverse was corrected by the phase reversal relay. Reversal of the carriage motor was accomplished solely by its own reversing contactor and push buttons.

*Electrical World, July 17, 1943, page 54 (254).

GENERAL COMMENTS

A sequence interlocking scheme for a coal-handling system depends to a large extent on operating experience since it is impossible to foresee and provide for all contingencies. Even the different kinds of coal carried sometimes affect this; for example, certain kinds of brush cleaners work in one plant and not in others. Tramp iron sneaking through the system during the short interval of time that a belt coasts after shut-down may not be intercepted if the magnetic pulley is de-energized too soon. Some unusual operating set-up may demonstrate that additional interlocks are needed to prevent the lavish flow of coal through doors and windows like a "Sorcerer's Apprentice" fantasy in coal instead of water. One plant operator may want a system replete with interlocks and provisions against every conceivable kind of trouble; another reluctantly yields his inclination for dispensing with all automatic features, to operating exigencies and labor shortages and fallibility. But in any case, designing a coal-handling control system is always a fascinating job.

The
PRACTICAL ENGINEER and ELECTRICIAN
ANDREW W. KRAMER, EDITOR

ON THE USE OF TOOLS . . .

After having mashed my thumb to bits with a moderately-sized hammer which any four year old should be able to handle with ease and dexterity I have just added to my general feeling of ineptness by reading "Invisible Worlds to Conquer." This interesting article by O. A. Battista in the July issue of *Steelways* tells all regarding the new science of Micrurgy. In case there are some others besides myself who are not on speaking terms with micrurgy let me hasten to say that it is the name given the work done by those devilishly ingenious guys who use tools so small that an entire kit of them can be carried around in an eyedropper.

It is now possible (says Mr. Battista) to split hairs, tamper with the chromosomes in individual life cells, pick out and tear apart individual rust particles on a metal surface or perform a complete chemical analysis on a pin point of blood.

An appraisal of the use of micrurgy in industry has been made by Charles Van Brunt of G. E.

"The composition of a speck of residual matter in the bottom of a tiny corrosion pit," he declared, "of the film of gum on a defective bearing, whether an electric clock or a turbine; of the faint discoloration on the bulb of a vacuum tube; of the smear of dirt on a contact; of a trace of process dust in the crevices of the windings of a burnt-out motor, determined by micrurgy, will usually lead to effective measures of correction with a minimum of wasteful trial and error."

One microspecialist assembled an electromagnet by using an extra-fine special needle as the soft iron core. He wrapped around this a wire as fine as spider's silk. With it he could remove minute particles of iron from crevices on the surface of the non-magnetic metal. Micrurgists invariably make their own tools—chisels, rakes, hammers, saws, hypodermic needles—to meet the special needs of whatever problem is under investigation. Molecular layers of oxide films have been removed from surfaces; pure strains of yeast have been produced by picking out a single yeast cell with micrurgical tweezers; the nuclei of individual amoeba have been removed and studied.

Sorry, fellow micrurgists, I must stop for repairs now. I just caught my finger in the typewriter keys.

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE
Technical Publishing Company
53 West Jackson Blvd., Chicago 4, Ill.

Maintenance of Industrial Electronic Equipment—I

The information contained in this series of articles is concerned only with the preventive maintenance techniques which are designed to maintain top efficiency in performance, to minimize unwanted, costly interruptions in service, and to eliminate major breakdowns. Trouble shooting and repair procedures are contained in the instruction book supplied with the apparatus and will not be covered here

PREPARED BY WESTINGHOUSE ELECTRONICS COMMITTEE

IN the design of electronic equipment for industrial use this company has taken into consideration the fact that the equipment will be called upon to operate for long periods of time without the attention of skilled electronic technicians. Therefore, circuits and components have been selected which will produce rugged, trouble-free apparatus. Once installed and placed in operation, industrial electronic apparatus will require only preventive maintenance to keep it in good operating condition.

Preventive maintenance may be defined as a systematic series of operations performed periodically on equipment in order to prevent breakdown. To appreciate the meaning of the term "preventive maintenance" it is necessary to distinguish between preventive maintenance, trouble shooting and repair. The primary function of preventive maintenance is to prevent breakdowns and the consequent necessity of repairs. In sharp contrast, the primary function of trouble shooting and repair is to locate and correct the existing defects.

Reason for Preventive Maintenance

Preventive maintenance procedures are designed to:

1. Protect the equipment from the detrimental effects of dirt, dust and moisture.
2. Keep the equipment in such condition as to insure uninterrupted operations for the longest possible period of time.
3. Maintain the equipment so that it will always operate at highest possible efficiency.
4. Prolong the useful life of the equipment.

The importance of preventive maintenance cannot be overemphasized. It acquires its proper significance when it is examined from the point of view of equipment utility. Equipment must be kept running efficiently if it is to serve its purpose. Equipment that is improperly maintained will rapidly become useless.

Preventive maintenance prolongs the useful life of industrial electronic apparatus and contributes to the success of the process or operation in which the equipment is employed. However, by its very nature, preventive maintenance requires the wholehearted interest of the personnel assigned to it. Persons charged with this responsibility should have a keen appreciation as to why the work is required and how important, even the most routine tasks, are to the over-all performance of the equipment.

Precautions During Preventive Maintenance Operations

Special safety precautions must be observed before and during the application of preventive maintenance procedures. Some electronic equipment employs high voltages which are dangerous to human life. Extrême care must be taken to assure that all power is removed from the apparatus before servicing. Discharge capacitors with a well insulated ground stick before touching them with the bare hand. Every effort must be made to avoid injury to personnel and equipment during preventive maintenance work. Familiarity with equipment is likely to breed carelessness. Pay strict attention to every safety measure. Death by electrocution awaits the operator or maintenance man who takes chances with high-voltage circuits. Careful operators or maintenance men make certain that every safety precaution is taken.

Parts such as tube envelopes and resistor bodies remain very hot for several minutes after power has been removed from the unit. Some units have a temperature so high that very painful burns will result if the bare skin touches them. A bad burn may cause involuntary movement of the arm or body which can damage the equipment, especially the tubes. If work is started immediately after the power has been removed from the apparatus, extreme care is necessary.

Careful handling of the equipment should become a regular habit. Space for working on parts, partially covered by other parts, should not be made by pushing, tugging and moving the parts out of the way. Always avoid unnecessary strain on wires, cables, connections and couplings.

Tools used inside the apparatus frame must be firmly grasped and special care must be taken to prevent the dropping of pliers, screwdrivers, and similar repair tools on breakable parts or that nuts, bolts and screws are not dropped into transformer windings or onto other circuit components which might become short circuited. A heavy tool dropped on a tube may break the glass envelope or shift the position of the internal element.

Basic Preventive Maintenance Operations

The actual work performed during the application of preventive maintenance is divided into six types of operations. These are: Cleaning, Inspection, Feeling, Tightening, Adjusting, Lubricating.

Keeping the apparatus clean will alleviate high-voltage flashovers and the resulting damage to parts. Cleaning the apparatus, both inside and out, is essential for good operation. Dust may be blown from cabinets using compressed air, free from moisture and at light pressure. Fiber glass filters must be cleaned at regular intervals and replaced when worn or too dusty. Periodic cleaning is more frequent on exposed parts than on those which are contained within the cabinet. Inspection may reveal that some parts require more frequent cleaning than others. If so, these items should be attended to on a regular schedule before trouble is encountered.

Inspection is probably the most important operation in the preventive maintenance program. Careful observation is required. A careless observer will overlook the obscure evidences of defects and abnormalities. Slight abnormalities may not interfere with the equipment performance, but these are deviations from normal that should be discovered early. Valuable time and effort can be saved if defects are corrected before they lead to major breakdowns. Operating personnel must make every effort to become familiar with the indications of normal functioning. In this way, signs of mal-functioning will be recognized more readily.

Inspection consists in carefully observing all parts of the equipment, noticing their color, placement, state of cleanliness, etc. Inspect for the following conditions:

1. **Overheating,** as indicated by discoloration, or other visual indications; also by heat radiated to the hand, thermometer or thermocouple.
2. **Placement,** by observing that all leads and cables are in their original positions.
3. **Cleanliness,** by carefully examining all recesses in the unit for accumulation of dust, especially between connecting terminals. Parts, connections and joints should be

free of dust and corrosion, and other foreign matter. In high humidity locations, look for fungus growth and mildew.

4. **Tightness,** by testing any connection or mounting which appears to be loose. This may be done by slightly pulling on the wire or feeling the lug or terminal screw.

The feeling operation is used more often to check rotating machinery, such as blower motors, generators, etc., and to determine if electrical connections, resistors, bushings, etc., are overheated. Feeling indicates the need for lubrication or the existence of excessive friction in rotating equipment and bearings. Normal operating temperatures of motors will permit the hand to be held in contact with the motor or bearing case for a period of approximately 5 seconds without discomfort. Feeling on capacitors, wiring, etc., may indicate an overloaded condition which should be corrected.

It is important that the feel operation be performed as soon as possible after power has been removed from the equipment and the circuit grounded, and always before any other maintenance is done.

Vibration from moving machinery may result in loose connections which are likely to impair the operation of the apparatus. All loose parts (especially if they are large) are definite hazards to associated equipment. If loose parts shift, or fall out of place, near-by parts may be crushed.

The importance of firm mounting and connections cannot be overemphasized. Screws, bolts and nuts should not be tightened indiscriminately but only when they are definitely known to be loose. Fittings tightened beyond the pressure for which they are designed may become damaged or broken. When tightening, always be certain to use the correct tools of the proper size.

Adjustment should only be made when inspection indicates that it is required in order to maintain normal operating conditions. The required adjustments vary with each type of equipment. Specific information on adjustments will be contained in the instruction book supplied with the apparatus.

Lubrication refers primarily to the application of grease or oil to the bearings of motors or other rotating shafts. It may also mean the application of a light oil to door hinges or other sliding surfaces found around the equipment. Certain parts of electronic apparatus are prelubricated at the factory and should require no further lubrication. Information on these parts will be found in the instruction book supplied with the apparatus.

Maintenance Techniques

Most of the parts used in electronic apparatus require routine preventive maintenance. Those parts requiring maintenance, differ in the amount and kind of maintenance required. Because maintenance techniques cannot be applied indiscriminately — definite and specific instructions are needed. This chapter contains this type of specific instruction and serves as a guide for personnel assigned to perform the maintenance operation. It does not deal with each tube, each resistor, and each capacitor contained in a specific piece of apparatus, but instead, combines all instructional material on major classes of parts and devices.

CAUTION: Before performing any preventive maintenance work on electronic apparatus, make certain that all power has been removed from the equipment and that capacitors have been discharged and circuits grounded before touching them.

Convenient means of making certain that a circuit is grounded is by the use of a grounding stick, which is not normally supplied with the apparatus. However, one may be made from materials which are usually found in any maintenance department. Use a piece of dry wood, or some other material that is a good electrical insulator. It should be about 12 inch long and ¾ inch in diameter. To one end of the stick securely fasten a piece of copper, or brass, about 8 inches long and at least 1/16 inch cross section in such a manner as to form a "T". Solder a piece of heavy flexible hook-up wire to the metal rod where it fastens to the stick. Attach a heavy clip to the free end of the hook-up wire. When using the grounding stick, fasten this clip to the cabinet frame, making certain that there is a good electrical contact. Then, place the rod against the capacitor terminals to short circuit and ground them prior to touching. In a similar manner discharge all circuits prior to touching them with the bare hand.

This series will be continued in the October issue of *Power Plant Engineering*.

Solved: The Mystery of the Misplaced Nut*

Strangely enough, when jam nuts are used, the apparently logical way of placing the nuts is incorrect . . . so, read the following tale which tells what is right

THINGS ain't always what they seem!

Frequently two nuts are used on a bolt. Often one nut is thin and called a Jam Nut. Ordinarily this jam nut is put on top, shown in Fig. 1, and wrenched lightly—just enough, it is expected, to lock the two nuts and keep them from loosening. Though this practice is wrong, it is seen more often than not, in spite of the fact that for thirty years textbooks on machine design have pointed out that the jam nut is misplaced when put on top. The jam nut should be the bottom nut and a full thickness nut should be on top and wrenched fully as shown in Fig. 2.

Let's see how a jam nut works. Imagine the bottom nut to be assembled and torqued only moderately, giving a pressure P on the work. Then let's put the top nut on and wrench it progressively so that its pressure against the bottom nut, P_o, increases from nothing to a maximum. Three cases arise with increasing P_o as follows:

Case 1. P_o less than P — In this case the top nut has been tightened only lightly in comparison to the bottom nut. Threads of both nuts are bearing upward in the same direction on the bolt threads. If the bolt tension were lost for one reason or another, threads of both nuts lose their bearing on the bolt threads and thereafter can rattle free. Clearly there is no locking effect here.

Case 2. P_o equal to P — In this case both nuts have been wrenched equally. The top nut bears on the bottom nut with the same force that the bottom nut bears on the work. P_o is equal to P and the difference in these forces, which is the load on the thread of the bottom nut, is zero. In other words, the threads of the bottom nut are not bearing on bolt threads in either direction. The bottom nut might just as well be a plain washer for all the good it does in locking.

Case 3. P_o greater than P — In this case the top nut is bearing on the bottom nut with a force greater than the bottom nut bears on the work. The difference in these forces is the load supported by the threads of the bottom nut and is downward against the bolt threads. Since the threads of the top nut are bearing upward on the bolt threads, the two nuts are bearing in opposite directions on the bolt threads and therefore are jammed and locked to the bolt threads. This locking effect remains even if the bolt tension is lost. This is the only case

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*Abstracted from "Fasteners" published by the American Institute of Bolt, Nut and Rivet Mfrs.

where locking occurs and since to arrive at this condition P_o must be greater than P, it is logical that the top nut, which produces the force P_o, should be thicker than the bottom nut. Threads of the bottom nut carry only the difference in P_o and P, which is relatively small.

Another point that should be noted is that the bottom nut need not be tightened severely to produce ultimately a high tension in the bolt. As the top nut is tightened the threads of the bottom nut first bear upward on the bolt threads (Case 1), then are free (Case 2), and finally bear downward on the bolt threads (Case 3). In this transition during Case 2, the bolt must be stretched sufficiently to reverse the thread contact. This stretching of the bolt through the bottom nut involves a proportionate increase in the bolt tension depending upon the looseness of thread fit of the bottom nut. The final bolt tension therefore is higher than that originally set up by the bottom nut. In fact, the tension may be higher than could be sustained by the bottom nut alone since most of the tension is now being supported by the thick top nut.

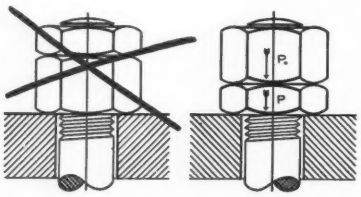


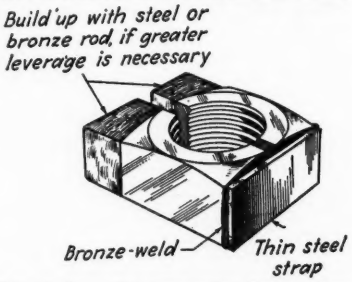
Fig. 1. Left, bolt is shown with thin nut on top and thick nut next to the plate. This is incorrect position since there is no locking action between nuts.

Fig. 2. Right, bolt is shown with thick nut on top and thin nut on bottom. When force P_o exceeds force P, there is a locking action between the nuts

Conclusions from the above are that the bottom nut should be the thin or jam nut; also, it should not have a tight thread fit if maximum bolt tension is desired. In assembly, the thin bottom nut should be put on with only a moderate torque and the thick top nut should then be wrenched on tightly with the full torque that the bolt can stand. In order to accomplish this full wrenching of the top nut, the bottom nut should be held from turning since the frictional resistance between the nuts may then be greater than that between the bottom nut and the work.

Stud Remover

IT IS easy to remove stud bolts from castings with this "persuader" without damaging the threads. Cut a nut of the proper size in half with a hack saw. Separate the two halves by the thickness of the hack saw blade and bronze-weld a strap of 1/16 in. steel to an outside corner of each half as shown. When the nut is screwed on the stud threads and gripped with a pipe wrench, the two halves bind and the stud can be easily turned out of its hole. If greater leverage is needed for stubborn or frozen bolts, the halves at the open end can be built up with steel or bronze rod.



This is how the persuader looks when finished

Blending Fuel Improves Combustion

By **JOHN F. SLAVINSKY**

PRIOR TO 1941 we were operating three chain grate stokers under 2-285 bhp cross drum water tube boilers and one 150 bhp HRT boiler. At the time this equipment was installed and put into operation we had ample boiler capacity. But as the years went by the company expanded and the plant started to outgrow the powerhouse. When this equipment was installed in 1924 we operated one condensing bleeder-type turbine and one uniflow poppet valve engine. As the power demand grew we had to add another turbine and then our troubles began.

Load Jumps to 400 Bhp

The two 285 bhp boilers supplied steam to the turbines at 180 psi. The 150 bhp HRT boiler supplied steam to the poppet valve engine at 125 psi. By 1930 our boiler load on the water tube boilers jumped from 285 bhp to 400 bhp. The load on the HRT boiler jumped from 150 bhp to 250 bhp. From that time on we were having considerable trouble maintaining proper combustion in our fire boxes.

We changed from natural draft to induced draft. Then we added an economizer to improve our feedwater temperature. After that we started to concentrate on the boiler combustion.

There was no rear arch in the fire box. When the stoker would be speeded up we would lose the ignition on the ignition arch. In order to get the arch hot we would shut the air off on No. 1 wind box under the stoker and back draft the fire by over balancing the balanced draft regulator.

In doing this we would decrease the underfire air in the furnace. Then help our ignition.
we decided to build a rear arch to

Every chance we had we installed a rear arch on the bridge wall until all the boilers were equipped. For a short time that seemed to be the answer to our problem.

The stokers were driven by a steam engine connected to a line shaft behind the boilers. This also gave us some trouble.

The stoker engine speed was governed or controlled by the damper regulator. When the damper opened up the engine would speed up. Soon as the engine would speed up the fire would pull away too fast from the ignition arch. When the damper would close the engine would run on momentum or coast a little too long and the fire would get too long.

Now It's 500 Bhp

So we took the engine out and put in a motor drive with a variable speed reducer. That went along fine for a while until the boiler load crept up some more on us. Before 1936 the two 285 hp boilers were pulling a 500 bhp load. The 150 bhp boiler had a load of 300 bhp. Our ignition troubles were such that the boiler operator did not have time to even eat his lunch while on watch. We were burning a mixture of No. 2 and 3 buck anthracite coal at this time and it seemed that the best was none too good.

Finally we began experiments by blending bituminous with our anthracite. After trying and missing a number of times (mostly trial and error methods) we finally worked out a mixture that was highly satisfactory in our case. We used a 5 per cent mixture of soft coal and our combustion improved to a degree where we continued this mixture until 1941 when we changed to the new boiler. The soft coal mixture in the fuel bed kept the ignition arch hot so that we had no further trouble in back drafting the boilers.

Alternating Current Made Easy—Part II

By EUGENE GEORGE KEY

THE FORMULA for Ohm's Law as applied to direct current is familiar to practically all electrical men:

(1) $E = IR$

In steady-state direct current, this formula applies very nicely in its simplest form. At the instant the circuit switch is closed, however, it obviously does not apply, as an examination of Fig. 1 will indicate. (Fig. 1 is the same as Fig. 3 of Part 1, where it was fully explained.)

When the switch is closed, the line voltage—which is also the load voltage since it is measured across both line and load—rises instantly to its maximum value. If the load is a large coil of wire which, on a 60-cycle alternating current shows considerable inductance, the direct current will rise gradually, taking as long as ten seconds and in some cases even

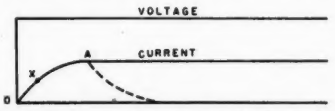


Fig. 1. If the current at any point later than A along the solid current line is multiplied by the resistance the result is line voltage

longer to rise to its maximum at A. If the current in amperes at A or at any point later than A along the solid current line is multiplied by the resistance, the result is as shown in (1) above—the line voltage. Obviously, however, the current between O and A cannot be used in (1), as the current is changing while the resistance and the voltage remain constant. The original Ohm's Law equation must be altered in some way in order to make it apply to conditions between O and A.

If more inductance is planned in the circuit, the current will rise more slowly, yet, unless some change is made in the resistance, the maximum value of the current will remain unchanged. If less inductance is used, the current will rise more rapidly, but the maximum value will, again, remain the same as before. Changing the resistance will make an appreciable change in the maximum value of the current, but very little change in the time required for the current to reach its maximum. Obviously, then, the inductance always causes the rising direct current to lag but has no effect on its maximum value. The only difference between equation (1), then, and the actual conditions between O and A in Fig. 1 is found in the action of the inductance. An apparently invisible voltage must exist in the coils of the inductance. Experiments have shown that this voltage actually exists and that it exerts an effect 90 electrical degrees out of phase with the applied line voltage, E. The true voltage equation, then, is as follows:

(2)

$$E = I(R + jX_L) = I\sqrt{R^2 + X^2_L}$$

where E is the line voltage, X_L is the inductive reactance in ohms, R is the resistance in ohms, I is the current in amperes, and j is an operator which means simply that the value X_L is 90 electrical degrees out of phase (different in direction of action) with R.

Equation (2) is the Ohm's Law equation for an alternating current circuit as well as for the voltages between O and A in Fig. 1. The value of X_L is given by the equation:

(3) $X_L = w\,L = 2\pi fL$

where w is the Greek letter *omega* which is equal to 2 times 3.14 times the frequency and L is the inductance of the circuit in henries. Although inductance was referred to with reference to a 60-cycle alternating current earlier in this article, it actually has a value that is independent of the frequency, even though the freqency is zero, as direct current.

Although the value X_L becomes zero after point A of Fig. 1 is reached (f being zero at that point), it is not zero between O and A. Since direct current does not change in direction, f, as applied to d-c (direct current) circuits merely refers to the rate of change of the current in relation to some frequency that has the same rate of change. This statement can better be understood by solving equation (2) for f, since all other values can be measured. Let $E = 100$, $I = 10$ at point X of Fig. 1, and $R = 5$. Then:

$$100 = 10\sqrt{25 + X_L}$$

from which we obtain:

$$10{,}000 = 100\,(25 + X^2_L) = 2500 + 100X^2_L \quad X_L = 8.66$$

If the inductance has a value of 2 millihenries, the value found above may be written:

$$(2)\,(3.14)\,f\,(2 \times 10^{-3}) = 8.66$$

Solving for the frequency, f:

$$f = \frac{8.66 \times 10^3}{12.56} = 0.70 \times 10^3 = 700 \text{ cycles.}$$

This solution indicates that at point X the inductive reactance has the same effect as it would if a frequency of 700 cycles were impressed on the circuit instead of a direct current. (Note: Calculations in this and other problems in this article are made on the slide rule. A recheck of X_L using f equal to 700 cycles gives it a value of 8.79 by paper calculation instead of the original 8.66. This difference is ignored by electricians and engineers.)

As the current rises, the value of f decreases until it reaches zero at point A. Going backward from X to O, the value of f increases to infinity at point O (current equal to zero).

The dotted line in Fig. 1 indicates the decay of the current when the switch is opened. This was mentioned in more detail in Part I of this series.

Since equations (2) and (3) are alternating current equations for the series circuit, it is seen that, actually, alternating currents are, fundamentally, pulsating direct currents which change direction. An electric circuit such as that described above does not differentiate between a rising or falling direct current and an actual alternating current which changes at the same rate. Since direct current does not change direction, inductive reactance is usually ignored in its study and steady-state conditions used in all calculations involving them.

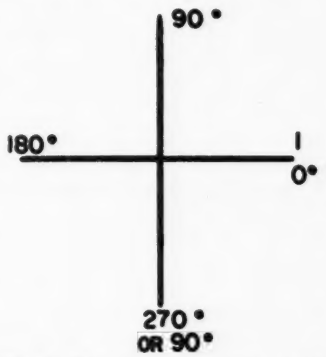


Fig. 2. This is the "reference vector"

Alternating currents are usually considered so complicated that vectors are drawn to illustrate voltage and current relations. These vectors cause further difficulty for the student and the practical electrician who uses them because of confusion concerning the so-called "reference vector." The "reference vector" of Fig. 2 is the line I. The line I, drawn horizontally to the right from the origin, O, is the reference vector, since this line is always considered to be at zero degrees, vectorially. The upward perpendicular drawn from O is 90 degrees in a positive direction from the reference vector. The horizontal line drawn to the left from O is 180 degrees from the reference vector in either a positive or a negative direction. The downward perpendicular is at 270 degrees from the

reference in a positive direction or —90 degrees in a negative direction.

The confusion over the reference vector is over the question of which value—current or voltage—to use. The rule that is easiest to handle is to use the value that alone is common to all parts of the circuit. Thus, the line current is common to all parts of a series circuit and is the natural reference vector for this type of circuit. All other circuit values are then considered in reference to the current vector.

Consider the circuit in Fig. 3, having resistance, inductance and capacitance. The inductance and capacitance is always considered to have zero resistance in practical cal-

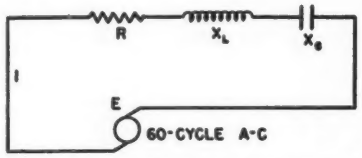


Fig. 3. Here the current is to be determined

culations because these values have such small resistance in comparison with their reactance values. Any resistance in these circuit parameters, as they are called, is usually "lumped" into the value R and used in that manner for calculations. It should be understood that although a condenser offers an infinite resistance to direct current—being an open circuit—it has exceedingly small resistance in alternating current.

Suppose in Fig. 3 the circuit values are as follows: R = 5 ohms, L = 2 millihenries (2×10^{-3} henries or 0.002 henries), C = 2000 microfarads (2000×10^{-6} farads or 0.002 farads), E = 100 volts, and f = 60 cycles. The current is to be determined, as well as the values and vectorial relations of all voltages present in the circuit.

During consideration of the direct current circuit, the calculations indicated that there were three voltages present in the circuit from O to A in Fig. 1. These are as follows:

1. voltage across the resistance, equal to IR.
2. voltage across the inductance, equal to IX_L.
3. voltage across the circuit, equal to the vectorial sum of IR and IX_L.

In the alternating current circuit of Fig. 3, there are four voltages: the three found in the direct current circuit and the voltage across the condenser, designated IX_C. The capacitive reactance from which this voltage is calculated is given by the equation:

$$(4)\quad X_C = \frac{1}{(2)(3.14)fC}$$

Calculating the reactances from (3) and (4), the following results are obtained:

$X = (6.28)(60)(2 \times 10^{-3}) = (377)(2 \times 10^{-3}) = 754 \times 10^{-3} = 0.754$ ohms

$$X_C = \frac{1}{(377)(2000 \times 10^{-6})} = \frac{10^6}{754000} = 1.328 \text{ ohms}$$

With the values thus obtained, the four voltage vectors can be placed in the diagram although the actual values of the voltages cannot be determined until the value of the current is found. In the present problem, plotting of the vectors will be saved until the last. The four voltages can be determined symbolically as follows:

$E_R = IR = 5I$ = voltage across the resistance, R.

$E_{XL} = IX_L = 0.754I$ = voltage across the inductance coil.

$E_C = IX_C = 1.328I$ = voltage across the condenser.

$E_L = IZ = I\sqrt{R^2 + (X_L - X_C)^2} = I\sqrt{25 + (1.328 - 0.754)^2} = 5.03I$ = voltage across line and load.

The value shown for E_L is based on the following equation:

$$(5)\quad Z = \sqrt{R^2 + (X_L - X_C)^2}$$

where Z is the total impedance of the circuit. (Impedance is the name given the total opposition that an electric circuit offers to alternating current or to a pulsating direct current.) This impedance is in phase with the line voltage which may be found from the equation:

$$(6)\quad E_L = IZ$$

The current, then, is:

$$(7)\quad I = \frac{E_L}{Z}$$

In the problem at hand, the current, I, is:

$$I = \frac{100}{5.03} = 19.9 \text{ amperes.}$$

The four voltages may then be calculated as follows:

$E_R = IR = (19.9)(5) = 99.5$ volts.

$E_{XL} = IX_L = (19.9)(0.754) = 14.8$ volts.

$E_C = IX_C = (19.9)(1.328) = 26.4$ volts.

$E_L = \sqrt{(99.5)^2 + (26.4 - 14.8)^2} = \sqrt{10003.4} = 100$ volts.

The calculation for E_L was merely a check on the calculation by resolving for the original voltage. As the square root of 10,000 is 100, the check shows an error of three parts in 10,000, which is extremely satisfactory. An error of one part in 100 is usually acceptable, and often errors larger than that can be considered satisfactory.

The voltages calculated are all plotted in their proper positions in the vector diagram of Fig. 4. The current, I, is plotted as the reference vector and is drawn to any convenient scale. In the same position but to a different scale is drawn the vector representing the voltage drop IR across the resistance. Drawn on the 90-degree line is the voltage drop across the inductance, drawn to the same scale as IR. Drawn on the —90 degree line and to the same scale is the vector representing the voltage drop across the condenser. Since the condenser voltage is higher than the inductance voltage, the latter was mathematically subtracted from the condenser voltage drop. On the vector diagram, however, relative directions of the drops must be considered. Vectorially, the condenser drop is negative and the inductance drop must be

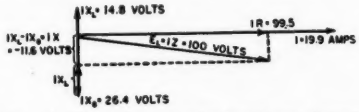


Fig. 4. The voltages calculated are plotted here in their proper positions

added to the condenser drop, leaving a net reactance voltage drop, IX, of —11.6 volts, indicating that the circuit is capacitive, and that the line voltage lags the current (or, as it is usually stated, the current leads the voltage). This —11.6 v is added vectorially to the 99.5 v of IR as shown, giving the 100 v of applied voltage as indicated on the diagram in Fig. 4.

In Part III of this series, the mathematics of the parellel alternating circuit will be considered.

Large Hydro Projects in Egypt

MINISTRY OF PUBLIC WORKS, Hydro-Electric Power Department, Government of Egypt, Cairo, has plans for two large hydroelectric power developments, designed to triple the present electrical supply in that country, which has a population of about 18,000,000 people. Proposed plants will secure water from the Nile and Mediterranean Rivers, respectively.

The initial plant will be located at Aswan Dam, which stores waters of the Nile, approximately 500 miles south of Cairo, and used for irrigation service at present time. This station will be equipped for a capacity of 345,000 kw. Plans have been completed and bids are being asked until July 18, with specifications available for purchase at the Royal Egyptian Legation, Washington, D. C. The other project, still in the development stage, will cover the construction of a canal and tunnel from the Mediterranean to what is known as the "Qattara Depression," a vast hollow, about 160 miles long. It is proposed to create a lake in that area, with surface approximately 120 ft below sea level. Water from the tunnel into this lake would be used for the water head of the generating plant.

Evaporation would be relied upon, it is said, to maintain the lake at the desired distance below sea level. The canal and tunnel would be about 45 miles in length; the Qattara basin is close to 380 ft below sea level at lowest point at present time. According to scientists, the bowl was created by winds blowing the desert sands. The capacity of this station and other details of project will be determined in near future. Project will include transmission lines, power substations, switching stations, distribution lines in different areas and other operating facilities.

How Hal Got Management to Cooperate

By HUBERT ETTELT

RIGHT NOW, it is more true than ever that the success and results of an operating engineer depend largely on the amount of cooperation he gets from the management. In small and smallest plants it sometimes requires an act of congress to wrestle from the boss permission for the purchase of a pound of packing. Where time and material cost are denied to the engineer for the urgent overhauling or replacement of highly unsafe and uneconomical equipment, he had better switch his allegiance to some other employer. However there are tricks in every trade. The engineer who wishes to gain the confidence of a distrusting boss, can possibly convert that stubborn opponent in the front office into a valuable ally in the power plant by psychology.

Hal, the young chief in a very small and busy plant had only one boss, a smart businessman who was unhampered by engineering knowledge. Between the two there were at first many hot arguments, whenever Hal requested or suggested something for the power plant. As time went on, Hal used to get his stuff without arguments and he began to wonder.

Once, after only one hour's deliberation, Hal obtained the boss' consent to buy a new boiler, the cost of which was quite a considerable item for so small a plant. Hal, mindful of former heated discussions on much smaller items, reminded the boss with a smile. The employer just grinned, then explained: "Hal, now don't jump on me for a raise of your salary. That has to wait awhile. But you are the first one among all those people working for me, who dares to say "No" right in my face. I am sick and tired of being yessed. I am no engineer and have different points of view as an executive. Yet somehow your technical reasoning seemed sound to me, and your first job here, the solving of the waste heat problem proved it. Don't ever let me catch you making any mistake in your department. I'll keep away from your kilowatt grinders as long as you don't try to run this office." The fact was, that Hal never disagreed with the plant owner, unless he was prepared with all the facts and proofs with which to back up his "No." I.e., he got his ammunition together before going into the fight.

As demands increased, so did the necessity for better boiler water treatment. When Hal reported this, which is always difficult to explain to a non-technical man, the boss just replied: "It's surprising what a variety of things like carbonates, hydroxides and what not are in the water we have, but how in hell do those Btu's or what you call it, get in our boiler?" With a superhuman effort Hal kept a straight face, explained and got the permission to buy colloidal treatment.

Sam, the colored fireman from Liberia, was a small and tough worker with an ambition. No amount of persuasion could dampen his enthusiasm for reducing the coal pile and keeping a heavy fuelbed in the furnace at all times. Only after Hal took coal scoop and slice bar for a few hours demonstration did it dawn to Sam, how much easier Hal's method of light and frequent firing was and how well the steam pressure kept up. He wasn't slow in copying that and within a week the daily coal consumption dropped from 9 to 6½ tons to the delight of everyone concerned except the coal dealer.

Later, Sam's appreciation of Hal knew no limits, when Hal rigged up an overhead monorail ash hoist from old scrap, some I beams and a chainblock. Then Hal made a special shaped ashcan. With this equipment, the fireman could remove at one trip some 600 lb of clinkers directly from the grating to the outdoors ashpile in one-tenth of the time formerly required for the same back-breaking job with the old wheelbarrow. Fireman's fatigue was so much reduced, that Sam volunteered for longer workhours, which in turn allowed one more production hour a day for war material.

With war restrictions, manpower—and material shortage, some of Hal's means to keep the plant rolling were of desperate nature. The replacement of a certain casting, which was cracked under the increased strain of war production would have caused months of shutting down of part of the process. Welding was possible, but the plant maintenance welding outfit was orphaned by the welder, then in the army. Local welding companies were too busy with other war work. So Hal went over to a big and nearby war plant, where he bribed one of the girl-welders with the promise of ample pay and two free tickets to a dinner and dance in a swanky hotel, to weld the casting in his plant.

After the girl's regular workhours at the big plant, she came over and did the job so well, that Hal had to change his opinion about women as welders. Of course, having no other chance, Hal had to, let's say, requisition the needed handful of special alloy welding rods from the big plant. The repaired unit went back in operation the next morning and replacement became unnecessary.

Let's be more careful with your diamond ring, Monahan! You're scratching the paint.

Training New Personnel in the Power Plant

GEORGE L. RADAMAKER

Experience and training methods in the U. S. Navy during the war can be utilized in the establishment of training programs and methods in stationary practice . . . Among other things the posting of operating instructions on every piece of equipment is important

DURING THE PAST FIVE YEARS on active duty with the U. S. Navy, the writer was constantly reminded of many of the apparent inefficiencies concerned with the operation and maintenance of the Fleet. However, one phase of efficient organization stands out and that is the comparative rapidity with which ships crews were welded into a smooth working unit. This in spite of the fact that by far the majority of personnel were untrained and inexperienced with only a small nuclei of hands with the "know how." Also, these crews had to be "broken in" on brand new equipment which would have tested the operating skill of most experienced stationary engineers. It is further remarkable that these crews were within sixty days or less ready and able to go into combat with the enemy in his home waters.

Several facts must be explained to show how this "magic touch" was administered and rapidly changed raw recruits into trained personnel. Foremost, of course, was the fact that on practically every ship that went into commission, all officers and men knew that in the not-too-distant future they would be under enemy fire, and they had better be able to produce or go for a long swim in very uncomfortable water. This was a mighty powerful incentive for doing a good job, and one which industry in peace time finds it impossible to duplicate.

Willingness to work and learn a job, of course, is not the whole story on whipping a crew together to beat the enemy, or similarily, in industry there must be more than an incentive to learn a job rapidly. To use an old cliche, "Now, here is the way we did it in the Navy":

1. Operating instructions posted over *every* piece of equipment.
2. Check-off lists for routine maintenance programs.
3. Supervised courses of study (movies, course books, lectures, examinations, etc.).
4. Drill, drill, drill, drill, drill.

I believe that the above list is fairly complete. Now to try to explain in some detail how each was put into practice.

Operating Instructions

Operating instructions posted over *every* piece of equipment. I have put in italic the word "every" as this is important, and should be important. Each item or equipment should have definite and complete instructions on: (a) How to start; (b) How to run; (c) How to stop; and (d) Safety precautions. The below operating instructions for a 250 kw turbine is fairly indicative of good practice:

A. STARTING

1. **Check oil level. Should be well above normal level on starting.**
2. **Drain main steam main to turbine.**
3. **Check oil temperature (must be at least 60 F on starting).**
4. **Open all drain valves.**
5. **Start condenser pumps (condensate pump, air ejector, and circulating water pump).**
6. **Bring vacuum to 15 in. or better.**
7. **Turn hand oil pump to start oil flow, turn on steam to glands.**
8. **Open throttle and start turbine rotating, check for any rubbing sound with metal rod. Bring up to 3000 rpm slowly.**
9. **Check oil pressure (8 lb on bearings), oil temperature (110 to 130 F normal running temperature) and flow.**
10. **Run at 3000 rpm for one hour.**
11. **Increase speed of turbine, increase vacuum.**
12. **Trip turbine to test tripping mechanism.**
13. **Close drains, open throttle wide.**

B. RUNNING

14. **Check lubrication system. After unit has gone on governor control and is operating properly, synchronize the generator with synchronizing device and connect to system. Apply a light load gradually by means of synchronizing device.**
15. **See that air is circulating in generator and exciter.**

Form B-1 U S S BLANK Fireroom

DAILY TESTS AND INSPECTIONS No._____

Boiler Division - Week Ending _____194__

Petty Officers in charge of each item of machinery or station in which located initial in space provided after inspection or test has been accomplished.

INSPECTION OR TEST	S	M	T	W	T	F	S
A. BLOWERS Jack over idle blowers by hand and move blower flaps by hand. a. Forced Draft Blower No. ( ) b. Forced Draft Blower No. ( ) c. Forced Draft Blower No. ( ) d. Forced Draft Blower No. ( )							
B. PUMPS Jack over all idle pumps by hand 1 Reciprocating Pumps. a. Emergency Feed Pump No. ( ) b. Fire and Bilge Pump No. ( )							
2 Centrifugal Pumps a. Main Feed Pump No. ( ) b. Main Feed Pump No. ( ) c. Aux. Circ. Pump No. ( ) d. Aux. Circ. Pump No. ( ) e. Fire and Flush No. ( )							
C. TURBINES 1 Jack over idle turbo-generators 1-1/4 turns by hand a. Turbo-generator No. ( ) b. Turbo-generator No. ( )							
2 Inspect parts under vacuum for air leaks. a. Turbo-generator No. ( ) b. Turbo-generator No. ( )							
3 Test sample from lube oil sump for water and condition. a. Turbo-generator No. ( ) b. Turbo-generator No. ( )							
D. BOILER FEED WATER 1 Test water in all steaming boilers for salinity and alkalinity. a. Boiler No. ( ) b. Boiler No. ( )							

"B" Division Officer.

Form B-1. A good example of a checkoff list used by the boiler division of a light cruiser

16. **Check oil level, bearing pressure and temperature.**
17. **Adjust handvalves on steam seal manifold to obtain proper steam pressure to glands.**
18. **Regularly determine temperature of bearings. A fair running temperature of return oil is 140 to 170 F.**
19. **Check vacuum to see that condenser is operating properly.**

C. SHUTTING DOWN

20. **Gradually diminish load to zero by means of synchronizing device.**
21. **Open generator switches.**
22. **Take off field. Shut off steam supply to packing manifold.**
23. **Trip throttle valve, by manual trip button, close throttle handwheel.**
24. **Close stop valve ahead of throttle, open drain valves.**
25. **Operate air ejector for about 20 minutes to draw all vapor out of turbine to avoid corrosion. Run hand oil pump until turbine comes to rest.**
26. **Stop circulating pump and condensate pump.**
27. **Take all precautions against steam bleeding into turbine as protection against corrosion.**

D. SAFETY PRECAUTIONS TURBO GENERATOR

1. **After overhaul, inspect carefully for: loose bolts, improper clearance, short circuits, broken insulation and tools adrift.**
2. **If running temperatures are excessive, the trouble shall be located and rectified before extensive running is undertaken.**
3. **In emergency the generator may be overloaded for short periods, but never above 25 per cent.**
4. **The designed rpm shall not be exceeded.**
5. **Any sparking of generator shall be rectified.**
6. **Keep interior and exterior of generator free from water, salt, dirt, dust, and oil.**
7. **If the emergency trip fails to operate properly, the generator shall not be run.**
8. **Do not use emery cloth on generator brushes, only sandpaper.**
9. **Watch for emergency trips to trip out during gunfire or depth charge attack.**

The above card was placed in a card holder behind plastic glass immediately above the throttle of the turbine in plain view of the operator.

With the shortage of trained personnel in many power stations, both small and large, the posting of definite operating instructions near the equipment will augment and shorten the time of training by older and more experienced hands.

Check-off Lists for Routine Maintenance Programs

In the Navy, it is required by naval regulations that signed check-off lists be submitted to the Chief Engineer by Division Officers on large combat ships, and by Petty Officers on destroyers and smaller combat ships. This, it might be noted in passing, was and still is a source of griping by those having to carry out the provisions of the check-off list. The check-off list used in the Navy is probably too detailed and involves too much paper work for use in most power plants; however, an adaptation of the check-off list may be used in the preparation of a proper engine room or boiler room log with entries as to required periodic tests and inspections. Form B-1 shown herewith is a good example of a check off list that is in use by the Boiler Division on a Light Cruiser.

Supervised Courses of Study

This definitely has an application no doubt only in the larger plants where supervisory personnel has the time to prepare, layout, and supervise the instructions and study periods. Definitely, this is an individual problem which must be solved for the particular plant under consideration.

In the U. S. Navy, a program was frequently laid out for use during the initial training and "shakedown" periods in which a definite time was set aside for general instruction and others for particular instructions. Under the classification of "general instructions," training movies were frequently used which explained the operation of boilers, turbines, pumps, refrigeration machinery, ship equipment, and many others. Individual instruction might be classified as "on the job" instruction, new men were put on stations under experienced personnel who explained to the recruit exactly what he was to do. When it was felt that he knew the job sufficiently well, a leading petty officer or commissioned officer would examine the man orally and practically as to his capabilities. If he exhibited sufficient knowledge, he was assigned to that station. However, his training did not stop there—he was shifted from station to station as frequently as conditions would permit, and, in this way, after a very short time, each man was capable of handling several individual jobs. This was, of course, more important in the Navy, where a possible shell hit or torpedo might wipe out a good portion of the engineering personnel, and those remaining would have to handle the station where men were casualties, as against industry where personnel would be temporarily lost through illness or accident. Nevertheless, it is important to keep moving men around on several different but related jobs in the industrial power plant if for no other reason than to keep the men on their toes and conscious of the fact that the steam they produce in the boiler room goes somewhere except "through that pipe in the bulkhead," which I had one "boot" fireman answer in reply to my question.

Moving the men around also keeps the men from getting in a rut, which is frequently followed by carelessness.

Drill, Drill, Drill, Drill

Well, this last item is rather a stiff one to simulate in an industrial plant. In the Navy, it means battle casualty drills and operational casualty drills and was usually stressed during routine General Quarters or, for the uninitiated, when "all hands" were at Battle Stations. Prepared questions were usually handed to individual men who gave an oral answer to such questions as: "You are receiving auxiliary steam from No. 1 fireroom, when a concussion is felt forward and steam pressure begins to drop rapidly. What do you do?" The man is expected to explain that he would secure steam stops from No. 1 fireroom, and cut in steam stops from No. 2 fireroom, together with such other changes as may be necessary. As long as the engineering plant is kept running, even after severely hit in action, the ship has a fighting chance, but when the engineering plant is secured, the ship is veritably a dead duck.

In industrial plants, where dollars and cents seem often as important as lives on a combat ship, it is also necessary to keep boilers on the line until others can be cut in.

Questions may be prepared by supervisory personnel which follow this category: "What would you do if the water dropped out of sight in the gage glass?" "What would you do if the bearings on the house turbine reached a temperature of 180 degrees (or some other nominal figure) after running only a short time?"

Above all, it is necessary to make each operator conscious of the fact that accidents do happen, and machinery does fail, and he must train himself by asking himself questions while on the job. I remember an old timer explaining to me years ago that if you did ask yourself what you would do if certain things happened in the plant, then solved the problem, somehow you retained the facts in your mind, and if that casualty did happen, you frequently went ahead and did what was right rapidly and without too much thought.

I have digressed a great deal in the above, but I hope a few of the items will be of help to plant engineers in training new personnel and returning veterans. I say returning veterans because many were misapplied, strange as it seems. One particular case comes to mind of a man who was assigned to the Gunnery Department in Fire Control, which has to do with range finders, radar, etc., for use in control of the naval gun fire on board ship. This man had said he had experience in Fire Control—he had been a fire extinguisher salesman. I do not remember what happened to him.

Fire Extinguisher Maintenance

FIRE PROTECTION authorities constantly urge proper maintenance and annual inspection of fire extinguishers to assure satisfactory operation in emergencies. The usual annual inspection may, however, be inadequate for the "EAS" devices (extinguishers approved by the Underwriters' and Factory Mutual Laboratories under Emergency Alternate Specifications) produced during the war, when lack of critical materials made necessary the use of substitutes.

A comparison between some of the

materials used in the standard units and those in their substandard counterparts will make clear why it is essential to be on guard against deterioration.

The shell of all 2½-gallon pressure units bearing EAS approval was made of steel instead of the copper which is used for the shell of the standard extinguishers. This was true also of one-gallon pressure type vaporizing liquid units. Steel is, of course, far more subject to corrosion than copper.

The inner cylinder of foam extinguishers, normally of tinned copper, was made of steel coated with porcelain enamel which was also used in place of brass in the construction of the pump in EAS pump tanks. Subject to cracking, porcelain enamel parts require frequent and careful inspection.

Pump packings, gaskets, and similar parts ordinarily made of natural rubber were made of synthetic rubber. Hose of all EAS extinguishers was made of reclaimed rubber. Loss of flexibility, with consequent cracking, must therefore be anticipated.

Unimportant to the proper functioning of an extinguisher but vital to its identification is the name plate. This was decalcomania on the EAS units, rather than the metal name plate which is soldered or welded to the shell of standard units. No satisfactory method for permanent application of the decals was ever found. It is therefore necessary to make sure the name plate has not peeled off or that the extinguisher type is identified by some other means so that when fire breaks out the extinguisher used will be suitable for the class of fire involved.

Engineer's Gold Mine

By **H. E. BROOKS**

How did the old chief always know the answers? How was he always able to answer all our questions? Did he just know everything? When he finally retired he gave away his secret and then we found that it was very simple

MANY YEARS AGO I had the privilege to work under the guidance of an old chief engineer, then in charge of a small, but highly efficient and immaculately clean plant. It was a privilege because he was of the type never tired or afraid of sharing his knowledge with his younger subordinates. Our endless flow of questions must have been at times an awful strain on his nerves. Quite often he gave us the answer only after hours or days, but he never failed to give a full, precise and clear answer to our questions. No wonder that we were soon convinced that the old chief knew everything in the broad and varied field of power plant engineering. Even the brass hats from the front office consulted him and mostly followed his advice, whenever a change of production machinery was contemplated or replacement for better equipment was desirable. Only once he had me stunned, when he ordered me to tell Frank, the night operator, that he, the chief didn't know the solution to Frank's problem of last week on the exact evaluation of the effect of wind velocity on a cooling tower. Frank, too, when I told him, almost felt his world crumbling up because of the unheard thing that the chief didn't know. But then it dawned on us, that there was more than merely engineering about the chief. That is, he was not afraid for his prestige to admit frankly "I don't know" instead of trying to save face by presenting some answer around the point, just about good enough for us two ignorant young squirts. After that, our admiration for the chief almost rose to devout reverence. Despite of the strict discipline he kept us in, he always tried to be fair. Probably it was that which consoled us in our hopelessness ever to acquire such an abundant wealth of engineering knowledge and training as he had.

He Gives Away This Secret

One day just before he retired from the job, and while he still was breaking in his successor, our future mentor, he called us both to his office. "Boys," he said, "for years I have endeavored to penetrate sufficient engineering through your thick skulls that some day you may call yourselves engineers without lying. Your own efforts to that end are as inefficient as a furnace with 5 per cent CO_2, if you forget what you have learned by the time you will need the knowledge. If you are confronted by an actual problem and can't dig the answer out of your think-tank, you got to have a gold mine, from which to get information on all your problems at an instant's notice. Such a gold mine is contained in this old file cabinet next to my desk. You'll find neatly filed in it some 250 folders about every article which I found in POWER PLANT ENGINEERING and the *National Engineer,* and which I considered to come handy some day for the operation of this plant where I have now worked for almost twenty years. In all these years this old file has not only become invaluable on the many hundreds of occasions, where I had to consult this file for information; it also became priceless for the owner of this factory, because of the time saved in working out the various hard-to-solve problems for this factory. Let's look, for instance, at folder '17,' marked 'Solid Fuels.' Aside of all the qualities of various coals, their characteristics, origin, furnace requirements and how to fire them to best advantage, you also will find in this folder descriptions of actual operating experiences by other engineers in other plants. Let's hope you punks never have to mix sawdust with soft coal, or coke breeze with rice coal. But if you have to, you'll find in this goldmine in folder 'Mixed Fuels' several valuable hints from engineers in other plants, how they handled those mixtures and what results they got."

Well, we punks found folders on Power Factor, Rigging, Combustion Control, Natural versus Forced Draft, Balanced Draft, Power Plant Accounting, Boiler Water Treatment, Lubricants, Transformers, Compressed Air Purification, Bearing Designs and Metals, Foundation Requirements, Condenser Tubes and on practically every detail of engineering which the chief had to put up or thought he may work on some day. Most of the things said in these folders would have been hard to find in most textbooks, but all of them were highly welcome additions to the respective discussions of these items in engineering textbooks.

Now I Have My Own Gold Mine

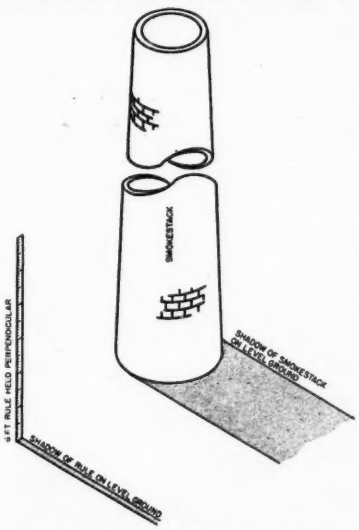
Ever since that time I have now my own gold mine in the form of an old file cabinet. Although it is not by far as complete yet as the old chief's, it has helped me a good many times and has many times repaid the little effort to maintain that file in good order and slowly growing in volume and value. Even when I was not uncertain how to tackle a particular task, that file has provided me with hints and practical advice, how to do a better job. Needless to say that an engineer's standing, his reputation, and chance for an increase of his salary, are so much better, the more he can be depended upon and the less an outsider has to be consulted. What good is it if an engineer in 1935 reads an article "How to Select a Boiler," forgets half of it, then in 1946 has to pick a boiler best suited for the particular conditions of his plant, but is unable to recall or find that article. Sure he will pick a boiler, but his difficulty would be far less, and he even may buy a better adapted boiler, if he had filed that article away for further reference, and were it only for helping a fellow engineer with it some day.

PRACTICAL HINTS AND KINKS

Height Finding

THE ONLY thing needed to find the height of a chimney is a rule and a sunshiny day. Choose an hour of the day when the shadow of the chimney falls on reasonably level ground, and measure the length of the shadow it casts. Then at any level spot draw a line on the ground at right angles to the shadow of the chimney.

Unfold the rule and hold it by its top section until it swings freely over and its lower end just touches the mark. Mark the end of the shadow



Shadows are cast in direct ratio to the height of the object

the rule casts by identifying a cinder or pebble it just reaches to, then lower the rule and measure the distance of this cinder or pebble from the original mark. This of course is the length of the shadow the rule casts when held perfectly vertical. Since the ratio of the height of the rule to the height of the chimney is the same as the ratio of the length of their respective shadows, the height of the chimney may be determined by proportion.

Stated as a rule: 6 times the length of the shadow cast by the chimney divided by the length of the shadow cast by the rule equals the height of the chimney. This assumes a six-foot rule.

Stated as a formula:

$$H = \frac{6S}{r}$$

in which: H equals the height of the chimney
6 is the length of the rule
S is the length of the shadow cast by the chimney
r is the length of the shadow cast by the rule

If S equals 225 ft and r equals 7.5 ft, then 7.5 : 225 : : 6 :

$$H \text{ or } \frac{6 \times 225}{7.5}$$

equals 180 ft which is the height of the chimney.

Marissa, Illinois — GEORGE HOLMAN

Using the Chuck in Layout Work

Many cylindical parts, turned in the lathe have to be drilled or slotted at certain points and the layout work may be done accurately in the chuck, before taking the part out.

For example, in making ring oiling sleeve bearings for electric motors, a slot for the oil ring, two oil drain holes, and one dowel pin hole must be lain out.

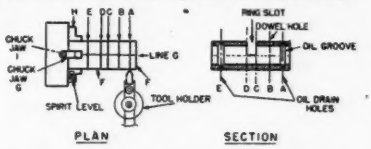
In this case, the dowel pin is one hundred and eighty degrees, or diametrically opposite the oil drain holes and the oil ring slot includes 180 degrees, ending 90 deg., (or on the quarters) between the Dowel pin and drain holes.

The procedure would be as follows:

After the bearing is turned and bored complete, and before cutting it off, take out the turning tool and put in a sharp pointed tool. Measure from the end of the old bearing being duplicated, or from the blue print, to the center of the first oil drain hole. Measure an equal distance from the end of the new bearing and adjust the carriage longitudinally until the point of the tool is at this point. Then start the lathe and adjust the cross-feed until the tool cuts a fine sharp line, the entire circumference of the bearing, as at A, sketch No. 1.

The tool is then moved longitudinally and the action repeated for a mark at the center line of the dowel hole, at each edge of the ring slot and at the center line of the drain hole in the other end of the bearing, as indicated — b, c, d and e — Sketch No. 1.

This establishes the longitudinal center lines. A spirit level may now be placed on jaw F of the chuck, and the work turned by hand until the jaw is exactly level. The point of the tool is now adjusted and the carriage manipulated by hand longitudinally, to draw the line F, and the action re-



Showing position of the work and of the cutting tool

peated for jaws and lines G, H and I. The bearing may now be cut off to length, the holes drilled at the proper cross marks and the slot milled out.

This is assuming that a four jaw chuck is used.

The same results may be obtained with a three jaw chuck by using only one jaw and a level with the ends square, the end of the level being used against the jaw in the vertical positions and the bottom used in the horizontal positions.

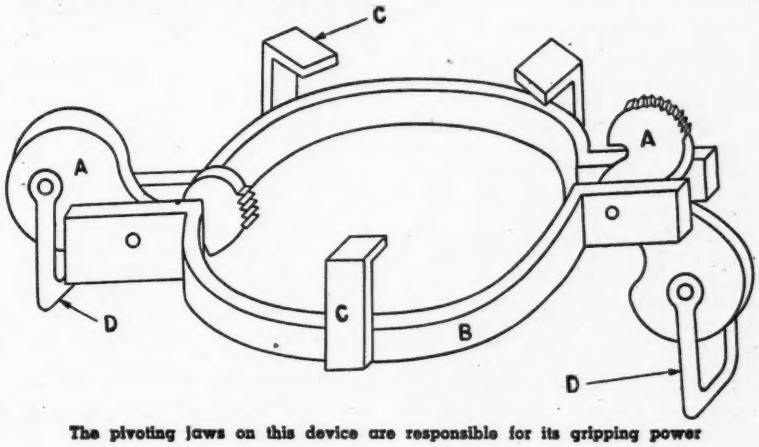
Alexandria, Va. — EARL PAGETT

Lifting Device for Cylindrical Objects

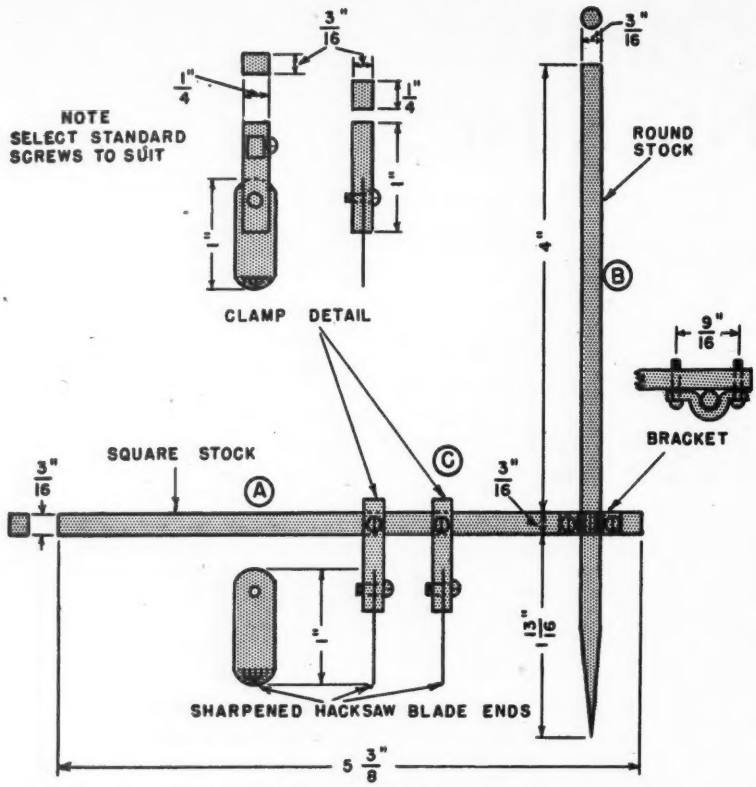
A LIFTING device for moving cylindrical objects to which it is impossible or impractical to attach cables or eyebolts is saving crane operator and crane follower man-hours at the General Electric Co. Schenectady Works.

As shown in the sketch, the device has two pivoting jaws (A) opposite each other on a ring (B). The jaws function in the manner of a pair of ice tongs in that they make the weight of the object being lifted exert the force to hold it securely.

Three inverted L-shaped pieces (C) spaced around the outside diameter of the band, position the device when it is lowered over the object to be lifted. Then a crane is attached to the clevises (D) on the two jaws, and the subsequent lifting movement pivots the two jaws down and inward so that they hold the positioned object firmly.



The pivoting jaws on this device are responsible for its gripping power



Details of home-made gasket cutter

Home-made Gasket Cutter

THE ACCOMPANYING drawing is of an adjustable gasket cutter or marker. It is used preferably for small gaskets that are hard to cut by hand. The size shown, is the size of the one I made but it can be made to any desired size or requirements. By sliding the adjustable clamps "C" along the cross-bar "A," any diameter of gasket can be either marked or cut, within the range of the cutter. This instrument is made from scrap material found lying around any shop. For rubber gaskets, the gasket sheet is laid on a table and held down while the cutter is held in a hand chuck by the shank "B" and turned, the sharp point holding the center while the blades, previously set to requirements, cut out the true gasket. For heavy, hard material, the cutter serves as a convenient marker for the gasket which can be then cut out with shears or heavy scissors or knife. This instrument is an idea of my own and is not copied from any manufactured product.

Baltimore, Md. CHAS. W. PARKS

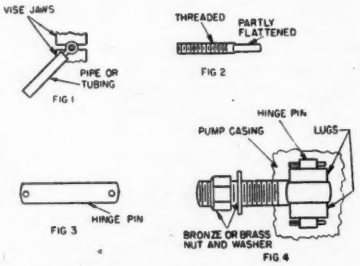
Stuffing Box Bolts

By THOMAS TRAIL

Where stuffing boxes on pumps and other apparatus are equipped with steel bolts and hinge pins, it is advisable to replace these with bronze bolts and pins. These can be made from bronze rod of the proper diameter. Bronze is stronger than brass and will give good service.

The bolts are made by placing a proper length of rod partly into a short piece of pipe or tubing of a diameter that will just tightly fit the rod, and heating the end of the rod projecting from the pipe. When sufficiently heated, the rod is bent around another piece of steel rod, of the proper diameter, clamped tightly in a vise, as shown in Fig. 1. If desired, the looped end of the bronze rod may afterward be flattened somewhat with a hammer, as shown in Fig. 2.

The rod is cooled and removed from the pipe, and then smoothed with a file and the end threaded.



Details of the stuffing box bolts

The hinge pins may be made from suitable lengths of proper diameter rod, Fig. 3. Drill a hole in each end of each pin, as shown, to take a cotter pin, and then smooth it with a file. The cotter pins used should be made of bronze, brass or other nonferrous metal, if possible, to prevent rust and corrosion.

This work of substituting bronze bolts and hinge pins for the usual steel ones on pump stuffing boxes should be done while the pump is still new, before they corrode and are difficult to remove. But in any event it is important that they should be changed. The completed change is shown in Fig. 4.

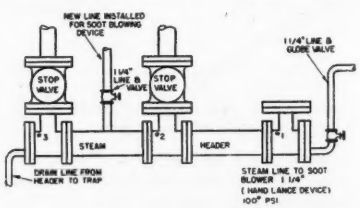
Keep the Steam Lines Dry

By T. F. CUNNINGHAM

POWER PLANT ENGINEERING has some good articles based on the mistakes made in power plants from time to time. Here is another one that describes something that should not have happened although it wasn't the fault of the plant personnel but of the outside contractor.

I'm more or less a trouble shooter in the several plants of this concern so I get to see most of these mistakes. The heating plant contains two 100 hp boilers and the pressure carried is 100 psi. In the heating season the use of the soot blower was a must because the fuel was soft coal.

This plant was down for ten years and two of the three boilers were overhauled when the power plant


NEW LINE INSTALLED FOR SOOT BLOWING DEVICE
STOP VALVE
STOP VALVE
1 1/4" LINE & GLOBE VALVE
STEAM
HEADER
DRAIN LINE FROM HEADER TO TRAP
STEAM LINE TO SOOT BLOWER 1 1/4" (HAND LANCE DEVICE) 100# PSI

Bringing the steam line in the top of the header resulted in dryer steam

was again put in operation; the third boiler was the first one installed many years ago, and it probably will never be used again. The sketch shows the main header. It also shows how the soot blower steam line was first installed resulting in wet steam and thus causing the soot in the tubes to become caked. This, of course, made the situation worse instead of better.

After changing the steam line to the top side of the header the steam was drier. This is what it was intended to have been in the original piping hook-up. The first steam line isn't shown fully but it ran against the weather or street side of the building and in the cold season this also was a contributing factor in causing the steam to condense. The new line is run about the same height

as the steam line from boiler to header and it is arranged so that it is run between the boilers on the boiler fronts.

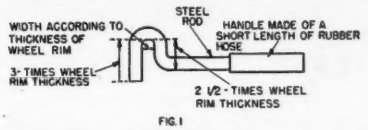
One important point to remember when planning piping is not to have legs in the hook-up unless this is needed for some reason. Also, keep steam lines drained of condensate at all times so that if steam is off the lines for some time that there will be little or no water in the lines.

Valve Shut-off Wrench

By THOMAS TRAIL

It is important that valves be closed tightly to prevent unnecessary wear of the seats and discs. But since it is usually difficult to shut valves tightly enough by means of the size wheels provided, especially on the larger size valves, a wrench that will provide sufficient additional leverage is useful. Such a wrench may be easily made, as shown in the accompanying figure.

It is convenient to have one of these wrenches handily located at each often-used valve. Also it is well to have one or more available and conveniently located to shut off important stop valves in an emergency, such as those on ammonia or other dangerous gas filled refrigerating systems.


STEEL ROD
WIDTH ACCORDING TO THICKNESS OF WHEEL RIM
HANDLE MADE OF A SHORT LENGTH OF RUBBER HOSE
3- TIMES WHEEL RIM THICKNESS
2 V2 - TIMES WHEEL RIM THICKNESS
FIG. 1

The details shown in this drawing will enable the engineer to make one of the valve shut-off wrenches described here

Various sized wrenches are necessary to fit different sizes of valve wheels.

The accompanying drawing (above) shows a simple, easily made type wrench that will prove practicable for use and one which can be made in the plant during your spare time.

LETTERS AND COMMENTS

The Power Plant Goes to Sea . . . but the Supervision Stays Ashore

IN THE interesting and valuable article by Lester M. Goldsmith in the April issue, POWER PLANT ENGINEERING, describing the substantial reduction in power losses accomplished by using automatic control and indicating and recording instruments in marine power plants, the following statements are noted:

"Even our modern Navy does not use flow meters as standard instruments, nor do they have combustion control, feedwater control, dual control, and so on." In fairness to the Navy, it should be remembered that a naval ship is primarily a fighting unit and must be capable of making complicated evolutions with the utmost reliability, promptness and accuracy under stress of battle conditions.

In such maneuvering the propelling machinery and auxiliaries are necessarily subject to sudden radical changes in load and operating conditions. Also, battle damage may require rapid shifting of work between the various auxiliaries to keep the plant functioning. All this places a high relative value on reliability and simplicity. Not only the fighting ability, but the very existence of the ship, may depend upon these requirements.

In commenting on some of the control features, Mr. Goldsmith states: —"This, of course, very rarely happens outside of pilot waters and inasmuch as the ship's time is spent 95 per cent at sea—." This condition is not generally applicable to naval vessels, which do a lot of maneuvering, even in time of peace.

The writer does not wish to be understood as belittling the value of automatic controls and instrumentation at sea, and freely admits ignorance of their shock-resisting qualities and ability to be readily disconnected if desired. Mr. Goldsmith's article speaks for itself as to the results achieved; and the types of instruments and controls involved have shown reliability through many years of use in shore power plants.

WILLIAM B. ROBINS

Philadelphia 44, Pa.

Parks on the 5-Day Week

IN THE JUNE issue of POWER PLANT ENGINEERING, E. E. Wilson, Keith Kimball and G. G. Avant offered comments on my 5-day, 40-hour week, work schedule.

I think that most of the trouble is caused by the wrong conception of a 40-hour work week. A 40-hour work week could be defined thusly: "No one employee shall work more than 40 hours in any one week of 7 days, regardless of when the week starts or ends, unless emergencies arise or the company is justified to do otherwise for short periods of time. For shift workers, this implies that there will be an 8 hour day of five days, with 2 days off in each week.

As there are 84 watches to be worked in each month of 28 days and there are only 4 crews of men and if each crew works 20 watches and takes off 8 days each month, there will be 4 watches left to be worked. This amounts to one odd watch in each week.

Where crews are large and skilled men have to be obtained, it is not always practical to carry an entire extra crew just for one watch each week even though they can do other work the balance of the time. Most organizations prefer to let the 4 crews of men work the extra watch each week, by one crew working 6 days for one week of every month and thus eliminating the entire extra crew. The men, in most cases are paid time and one-half for this extra day but they are considered as working on a 40-hour basis and not 42. When summer shut-downs come and the men are retained to do maintenance work, they work 40-hours a week and take 2 days off unless some special emergency arises.

Where paid vacations are given, the men get paid for 40 hours and not 42 even though the average work week was 42 hours. In many cases, where the plant operates all the year round, extra crews are employed to work during vacations. Some companies prefer to let the 4 crews work 7 days a week for vacation relief but you don't say you are on a 56 hour schedule. You merely say that you are working 7 days during vacations. The office, on hiring men, say "We work a 40 hour week here but you will have to work 6 days of one week every month."

G. G. Avant says that if men start to work on Sunday, Jan. 6 and work through to Jan. 12, "A" will work 6 days, "B" will work 6 days, "C" will work 5 days and "D" will work but 4 days. If Mr. Avant had started the days column with Sunday instead of Monday and had arranged the dates to suit he would have a different story. He would find that, "A" worked 6 days, "B" 5 days, "C" 5 days and "D" 5 days just as any other 4 crew schedule would do.

Mr. Kimball says that with my schedule, A, B, C, and D works 7 days of the 7-3 shift, 7 days of the 3-11 shift, 7 days of the 11-7 shift and with only 7 days off each month. This is true but no man works more than 5 days without a day off. When I submitted this schedule, I left it to the readers to realize that it was designed for 4 crew operation and that with any 4 crew schedule, there will always be an odd shift to be taken care of in some manner. It is obvious, that if a substitute can be obtained for the one odd shift each week, then "A" and his crew will work 5 days and have 2 days off just as any one else. It is further obvious that if there is only one or two men to be considered this might easily be accomplished, but where there are large skilled crews of men to be considered this constitutes quite a problem and in some instances is next to impossible.

Baltimore, Md. CHAS. W. PARKS

Questions And Answers

Question No. 344

What Is the Cantieny Principle?

IN THE December, 1945 issue under Letters and Comments, I noted with much interest the letter from E. Emerson in England asking for comments on certain operating phases of his 1500-psi power plant, also the very interesting and informative comments on boiler feed pump control by Sabin Crocker, Jr. in the March, 1946 issue.

In Mr. Emerson's original letter in the December issue, there was one term with which I am not familiar and I should like to have further explanation of it. What is the Cantieny principle on which, he states, two of his 1500-psi boilers operate?

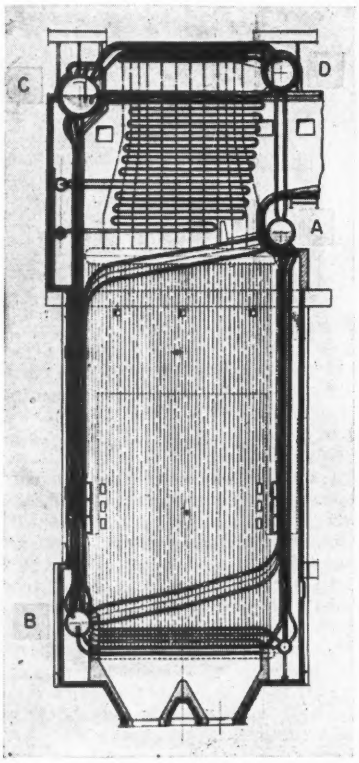


Fig. 1. Cross-section of Cantieny boiler showing relative locations of drums. Such boilers have been built for pressures up to 1950 psi and outputs up to 350,000 lb per hr

From the context of his letter, I assume that this must be a natural-circulation principle of some kind, because he states "two of these boilers operate on the Cantieny principle and three have forced circulation."

Chicago, Ill. E. R. C.

The Cantieny boiler, we are informed, is a design of natural circulation boiler employed by International Combustion Co., Ltd., which has constructed boilers of that type in England. One of these units is shown in Figs. 1 and 2.

It has a furnace chamber rectangular in plan surrounded by water tubes on four sides, top and bottom. Two sides and the top and bottom of the furnace form a separate circulatory system with two drums (a) and (b) set diagonally of the parallelogram, and the tubes of the other two vertical sides each form another separate system.

All of these systems, while operating independently as far as circulation is concerned, are linked together by banks of tubes. Thus the main steam and water drum (c), situated above the convection bank, has a bank of down-comer tubes feeding water to the lower drum (b) of the parallelogram, and these form the main means of introducing the feed into the boiler. There is a subsidiary drum (d) situated slightly above the main drum (c), and into this the steam generated in the six tube banks forming the walls of the combustion chamber is first passed. The water entrained in the steam is passed back into the three separate circulatory systems forming the combustion chamber boundaries, and the steam passes over into the main steam and water drum (c).

The area of the steam tubes connecting the upper drum of the parellelogram to the subsidiary steam drum is such that there is set up a sufficient differential pressure between this drum (a) and the main steam drum (c) to ensure that there is a steam space in the upper part of drum (a). By this means the steam which is released from it is substantially free from water. This is a very valuable feature, as it enables this system to be used for increasing the output from existing boilers by installing in the furnaces an arrangement of banks of tubes lining the walls and connected up to two diagonally opposed drums, similar to tha described, the whole producing steam in large quantities without disturbing the circulatory system of the boiler.

In contradistinction to boilers of this type as hitherto made, in which

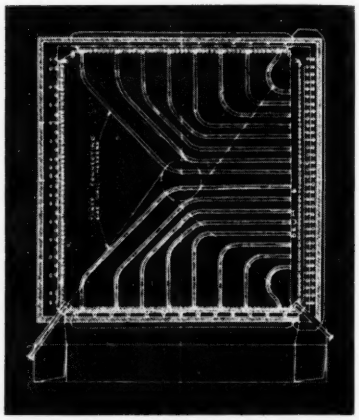


Fig. 2. Plan of Cantieny boiler shown in Fig. 1

the circulation in the drums is longitudinal towards the down-comers at the ends of the drums, the Cantieny boiler has down-comer and riser tubes spaced the full length of the drums, with the result that the circulation is circumferential and unrestricted.

We hope a little later to be able to show more details of the forced circulation boilers referred to by Mr. Emerson, together with some comments on the comparative operation of the two types of units having identical output and installed side by side in the same station.

Answer No. 318

How Burn Butane Under This Boiler?

Further Comments from Andrews

I SHOULD LIKE to add to the comments on butane given in the April issue with the hope that these remarks may be beneficial to C. L. H.

Although butane is normally found in refinery gas, special precautions should be taken in burning butane alone, either as a gas or a liquid. Butane is relatively heavy when compared with other hydrocarbons normally present in refinery gas, but it is relatively light when compared with all hydrocarbons, including the various liquid fuel oils available on the market.

When considering butane as a gas, I do not believe that preference should be given to burners which premix the gas and air within the burner proper, nor that there is any particular need to use either forced draft or preheated air, although there is no specific objection to such equipment. It is important, however, to guard against condensation in the burner supply lines.

For information on a vaporizing

system, I suggest that C. L. H. refer to the Propane-Butane Handbook, published by Western Business Papers, Inc.

It is also possible to burn liquid butane in atomizing-type oil burners designed with proper orifices. Steam atomization could be used or not used, as desired, depending on the supply pressure. The liquid butane would have to be pumped to the burners as it would not be practical to deliver it through any long supply line from a flash receiver because vaporization in the line and the burner would cause difficulties. Anyone planning to burn liquid butane must realize that it is an extremely explosive material more volatile than any motor or aviation gasolines. The only reason I mention the use of liquid butane at all is that it might be more economical for outdoor installations in some special cases.

Roxana, Ill. GLENN N. ANDREWS

Answer No. 296

Readers Helped Them Decide Whether or Not to Install These 750-kw Turbine Generators

IN THE MAY, 1945 issue, C. F. M. outlined the steam conditions in his plant, stated that they were considering the purchase of two 750-kw turbine generators to generate their power instead of buying it, and asked readers whether or not this would be the best thing to do. Q & A readers will be pleased to learn that their advice to C.F.M. has greatly aided him and his company in reaching a decision. This decision is not to install the two proposed turbine generators but instead to install a smaller capacity uniflow engine generator set. C.F.M. wants us to transmit his thanks to the many engineers whose comments on the situation proved so practical and helpful.

Answer No. 319

What Should His Fuel Oil Temperature Be?

Andrews' Comments

The temperature the No. 5 fuel oil should be as it leaves the heaters depends upon the type of burner installation and boiler design involved. The purpose of the heater is to make the oil fluid enough; in other words, of the correct viscosity so that it may be properly atomized in the burner and completely burned. The temperature of oil for proper atomization, therefore, is related to viscosity rather than to flash point or fire point.

A typical No. 5 fuel oil at 100 F will have a test viscosity between 75 and 150 sec. in a Saybolt Universal viscosimeter. The Babcock & Wilcox Co. recommends 135 to 150 sec. Saybolt Universal as the ideal viscosity for proper atomization of fuel oil in its mechanical atomizing burner or its steam-mechanical atomizing burners. This means that 100 F is correct for proper atomization of No 5 fuel oil with their steam-mechanical or mechanical atomizing burners There are, however, certain boiler installations which operate with relatively cool furnaces and/or widely varying loads. Such installations may require fuel oil temperatures ranging within 50 F of, but in no case above, the flash point in order to obtain complete combustion.

The Pensky - Martens closed - cup flash point for No. 5 fuel oil normally tests about 225 F. The Cleveland open cup flash point for the same oil would be normally slightly higher, say 230-235 F. The Cleveland open cup fire point of the same oil would be normally 30-40 higher than the flash point, say about 260-270 F.

If J. C. P. were to burn No. 5 fuel oil in steam-atomizing burners at 90 F tank temperature, the probability is that he could do this fairly well. I have had experience in power plants that regularly burn 4,000 barrels per day of fuel oil considerably more viscous than No. 5, ranging up to 1,000 sec. Saybolt Universal at 100 F, and this oil normally is heated to 150 F. Average boiler efficiency is better than 83 per cent, which corresponds with the design condition.

To be more specific, the answer to J. C. P.'s question is that he cannot determine the correct temperature of his No. 5 fuel oil as it comes from the oil heater when all he knows about the oil is its flash point. J. C. P. should find out from the manufacturers or suppliers of his equipment the viscosity required at the burner. His oil supplier can then tell him the temperature at which the heater should be operated.

Under no circumstances should the temperature in the heater exceed the flash point of the oil, as this may lead to hazards and poor burner performance. If the fire point should be exceeded, the hazards would be increased and carbonization within the heater, lines and burner may result. If severe carbonization is occurring in the oil heater, it is reasonably certain that either the design or the operating conditions or both are incorrect.

Roxana, Illinois GLENN N. ANDREWS

Answer No. 331

How Build This Walk-In Refrigerator?

IN THE MAY issue, M. J. B. asked for information about materials of construction, insulation, compressor capacity and other details for building a 6-by-6-by-6-ft walk-in refrigerator for use in a home dairy.

We referred him to the standard text data for making the necessary designs and calculation and then, in the June issue, published a detailed reply from our good friend George Holman, showing just how this refrigerator could be built.

Now comes a further interesting comment. It was natural that somewhere in the Department of Agriculture this problem, a common one on the farm, would have received proper attention—and it has.

Several Publications Give Details of Milk Cooler Construction

To HELP M. J. B. still further, I wish to call attention to a number of publications available, in addition to those mentioned, on the subject of milk coolers.

U. S. Department of Agriculture, Farmer's Bulletin, No. 1818, Mechanical Milk Cooling on Farms. Copies at 5 cents each from Superintendent of Documents, Washington, D. C.

Editor's Note—Mr. Hienton kindly sent a copy of this bulletin, which we have forwarded to M. J. B. It is very comprehensive, explaining clearly and in detail, with drawings and photographs, such items as: types of machines; costs of outfit; location of machine; controls; capacity required; sizes and construction of boxes; storage tanks; methods of operation; working drawings for construction.

Pennsylvania State College, Agricultural Experiment Station, State College, Penna., Bulletin 375, Electric Milk Refrigeration on the Farm.

Oregon State College, Agricultural Experiment Station, Corvallis, Ore., Station Bulletin 268, Mechanical Refrigeration of Milk in a Tank Type Refrigerator.

Purdue University, Agricultural Experiment Station, Lafayette, Ind., Bulletin 363, Some Factors Affecting Mechanical Refrigeration for Dairy Farms.

TRUMAN E. HIENTON
Head of Division of Farm Electrification, U. S. Dep't of Agriculture
Beltville, Md.

Answer No. 336

What's Wrong in This Refrigeration Plant?

Detailed Analysis by Ruppright

TO ANSWER this question exhaustively I would like to set forth a few points dealing with the fundamentals of the case.

Proper Temperature

Why is —20 to —30 F desired? A temperature of —10 F will keep practically everything indefinitely. For fast freezing (as distinguished from frozen storage) lower temperatures should be used, but even —40 F and somewhat lower will not eliminate the necessity for intensification of contact (to prevent surface-film resistance from slowing down the heat transfer) by either air blast or brine fog or syrup circulation or brine immersion or plate pressure.

Humidity Control

Refrigeration to temperatures above 20 F will not suffice for preserving perishables such as meat, and reduction of humidity of the air in the cooler must be employed simultaneously. Complete dehydration would

suffice for indefinite preservation just as well as —10 F storage but it obviously should be employed only for long-term storage, especially where saving of space and weight is required, as with transportation under primitive circumstances.

This makes clear that the reduction of humidity in a cooler must be kept within a certain range, which requires knowledge of how to control it. This is done by one or both of the following factors:

a. The humidity in the cooler decreases with increase of heat passage through the cooler, i.e. the poorer the insulation, and/or the larger the surface compared to the volume of the refrigerated space, the drier will be the air in the cooler. If the insulation is too thick, or the outside temperature drops too near the cooler temperature so as to furnish an insufficient amount of heat to flow through the cooler, then the humidity gets too high for preservation at cooler temperature (meat gets slimy, and an electric heater must be placed in the cooler).

b. The other main factor is the difference between cooler temperature and evaporator temperature. The greater this difference (the colder—and smaller—the evaporator) the drier will be the cooler air, and vice versa. This implies that the 36 or 37 F rooms cannot be satisfactorily operated with the same back pressure (refrigerant temperature) as the below-zero rooms, and that the described practice "use all the machines to draw from all the freezers and coolers" is definitely objectionable.

Ample Insulation—Ample Coiling

Unless every bit of freezer goods is packaged in such a manner as to perfectly prevent any exchange of moisture to or from it, low humidity in frozen storage and in freezing rooms is objectionable because it desiccates the goods. It is therefore imperative that these rooms be amply insulated and amply coiled. The latter can be roughly judged by the refrigerant temperature (back pressure) required for maintaining the desired room temperature (10 deg at most).

Heat Exchanger

The use of a heat exchanger in the freezer circuit is a measure which is justifiable only in an emergency. The work done by the evaporation of the refrigerant is composed of the heat to be removed from the room plus that which is contained in the liquid refrigerant above the evaporator temperature and which must be removed from it before this can receive any heat in the evaporator. A heat exchanger can remove only a small part of this latter; first because no heat exchanger can fully equalize temperatures even if it were immensely large; second, because it takes about 2 pounds of gas to be warmed one degree for cooling one pound of liquid one degree.

Therefore, what the heat exchanger mainly does is to superheat the gas. This results in two highly objectionable phenomena: it enlarges the volume of the gas and by that not only increases the pressure drop required for moving the gas to the compressor but also requires a directly proportional increase in the volumetric compressor capacity. Second, it raises the compressor-discharge temperature which already borders on the unbearable with low-temperature work.

Flash Tank

The following should be done. The low-temperature evaporators should be fed liquid from a flash tank. This is a vessel which is connected to the system as if it were another evaporator like those in the coolers but with an enormous thirst for liquid refrigerant. In this flash tank evaporates such a percentage of the liquid (and returns to the compressor as a gas) as will furnish enough refrigeration for cooling all the liquid down to evaporator temperature, say 25 F. This cold liquid then goes to the low-temperature evaporators with resulting increase of their efficiency for the above reasons. A further advantage is that the Btus removed in the flash tank are not dropped to the freezer level and therefore are lifted to the condenser level with less expense.

Two-Stage Compression

The gas from the low-temperature evaporators should not be pumped directly into the condenser, because the ratio of compression is too high for economy

$$\frac{180 \text{ psi abs condenser pressure}}{15 \text{ psi abs evaporator pressure}} = \frac{12}{1}$$

The main factor in this respect is that no compressor can empty the cylinder fully at the end of the compression stroke. The greater the difference between intake and discharge pressure, the further will this undischarged gas fill the cylinder by its re-expansion in the first part of the suction stroke and by its presence will exclude much fresh gas from the cylinder.

Booster

For pumping the freezer gas up to cooler-evaporator pressure (booster service), select that one of your compressors which has the proportionately largest valve area and the smallest valve-disc weight. Speed it up as much as will increase its capacity (limited by the valve-area vs. piston-area rate) and check if the motor should not be replaced by a smaller one for improvement in power factor and efficiency, because it takes much less power to lift Btus from —25 to +25 than to 75 F.

Undue Pressure Drop

A 15-in. vacuum theoretically means —50 F and in this case indicates undue resistance to flow between evaporator and compressor intake. This calls for investigation of what causes it, although the reduction of gas volume prescribed above under "flash tank" will alleviate this trouble somewhat.

Thermostatic expansion valves (superheat actuated) have the disadvantage of requiring superheat but they adapt the expansion-valve opening automatically to changes in load (as a float valve does), usually more than offsetting their disadvantage. However, to save the operator this work on some evaporators and leave it to him on the others is a half-baked measure. But to answer the question precisely: of interference there should be none.

Oil Traps

All compressors should have oil traps directly returning to the crank case. Oil never did any good in a condenser, and it does a lot of bad in any evaporator. All compressors pump some oil, but when the amount becomes big enough to exclude gas noticeably, the compressor must be overhauled, eventually oil rings be employed, and/or thicker oil be used. But first of all: is the oil level not too high in the crank case?

SIEGFRIED RUPPRIGHT

Los Angeles, Cal.

Answer No. 337

He Wants to Convert from Stoker to Oil Firing

TO CONVERT the boiler shown in the accompanying drawing from the present stoker firing to oil firing, asked C. W. H. in the June issue, what is the best way to go about it? 1—Should he use a mechanical or a steam atomizing burner? 2—Forced or natural draft, the latter 0.6 in. of water? 3—Should the bridge wall be removed and the furnace walls coated with plastic refractory? 4—Should present furnace brickwork be completely replaced? 5—Should the furnace floor be air-cooled? 6—What is the best way to make the change?

Conversion Suggestions by McMullin

Here are some answers from experience on the same type and size of boiler, taking up the questions in the order asked:

1. Mechanical burner.

2. Natural draft; control damper by hand.

3. Bridge wall in its present position can be used as a target wall for burner. If side walls are in good condition, leave as they are, but coat them with plastic refractory, also the target or bridge wall.

4. If in good condition, do as in No. 3.

5. No.

6. Pull out your stoker and grates and find the center of the front end plate. If there are many openings or holes in the front end plate where the stoker came out, get a blank piece of boiler plate and attach it to the front end wall. Then get the true center, place whatever type mechanical burner you have on the plate dead center. You will have to burn a hole out of the plate the diameter of burner. (The Shutte-Koerting burner is a good type.)

Your firebox floor and combustion floor should be bricked and the blow-off pipe insulated properly. Target wall should be squared away or slightly inclined at the top toward the burner. The front wall where the burner goes into the firebox should be coned so the flame will spread. Also, the combustion floor should have an incline—from 79 in. at the target wall to about 2 ft. less at the back end of the combustion chamber.

The blowdown pipe should run from the boiler down under the combustion floor, then out the back wall as shown. Cover this pipe with asbestos all the way from the boiler to the wall outside. Build a V-shaped protection wall from the combustion floor up to the boiler around the blowdown pipe, where this protection wall nears the boiler, leave enough space so the brick work does not touch the boiler and place in this space asbestos rope to take care of expansion. This wall is to be built from firebrick.

I don't see that there is need for another oil heater. A heater is used to heat oil, not to hold it. If C. N. H. sees that the temperature is lowering, why not open up on the steam to the heater? I don't know how hot he carries his oil but from long experience I have found that the hotter you keep your Bunker C, the better the results. I have carried this type oil as close to 300 F as possible and with mechanical burners you get the best results.

Camden, N. J. JOSEPH A. McMULLIN

Conversion Ideas from Gerbig

ON THE CONTEMPLATED changeover in firing equipment from coal to oil I would recommend using a rotary-cup type burner with full automatic controls, such as a Petro or Ray burner.

In changing over from coal to oil, your setting will require some redesign. This part of the job should be given as much consideration as the firing equipment, if not more. The setting height of the boiler should be no less than 8 ft. from the boiler floor level to the underside of the shell.

I would definitely not recommend coating over the present walls with plastic firebrick as this practice is not advocated by the manufacturers of this material. Your present setting can be patched in to make a satisfactory installation, if the existing refractory is in good condition. If you plan on making your installation a start-and-stop operation, expansion and contraction will be one of the main points to take into consideration.

If the present setting is questionable, then due consideration should be given to completely resetting this boiler and very serious thought should be given to either suspended air-cooled walls or suspended insulated type walls, either of which will eliminate common brick retaining-wall maintenance. A plastic firebrick setting of this type is preferred to be installed by a well-known concern with experienced mechanics.

It is not absolutely necessary that the floor be air cooled. If you keep the present setting, it would be possible to lay another 4½ in. of firebrick over the floor as no doubt there is 4½ in. in the floor at present. The floor gets a greater amount of abuse with oil firing than with coal firing, unless, of course, you would be firing with pulverized fuel. Should you decide to reset this boiler, then either of the two types of construction could be applied, which will result in a very satisfactory installation; 2½ in. of insulating firebrick on top of the concrete mat and then covered with 4½ in. of firebrick or 4 in. building tile on top of the concrete mat, covered with 4½ in. of firebrick.

I believe the best procedure to do this job would be to select the burner equipment complete, get all the information necessary as to what they recommend for the checker work and burner cone, etc. I would then contact a good, reliable boiler setter and have a survey made of the existing boiler setting, to determine the possibility of patching this up or the necessity of a complete new setting. By all means get a good refractory installation with your new burner.

CHARLES GERBIG

The Ramtite Co.
Milwaukee, Wis.

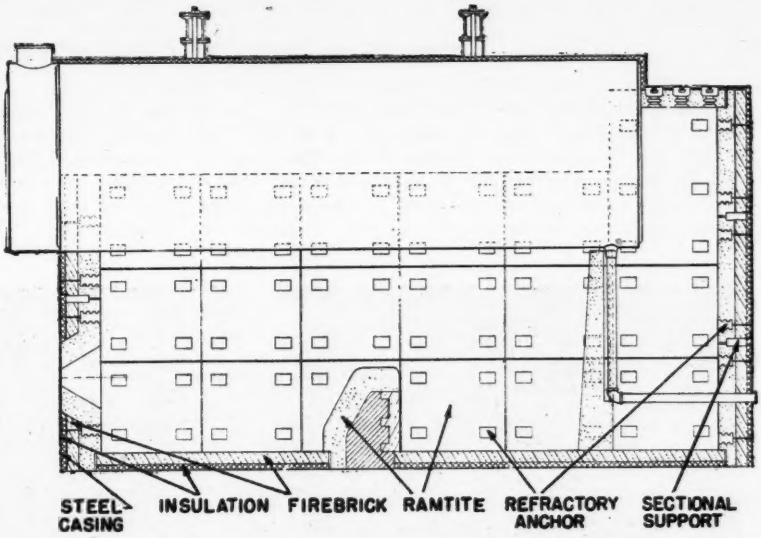
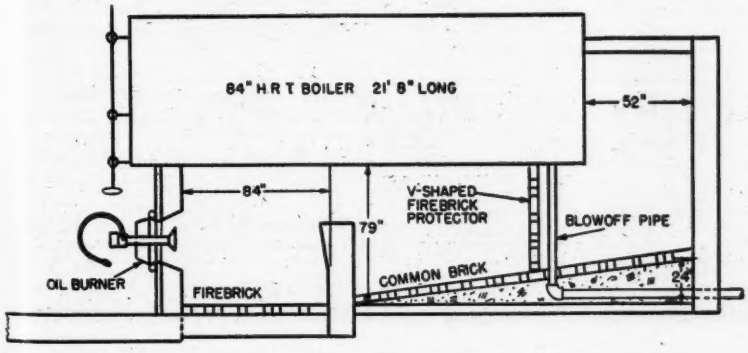


Fig. 1. Drawing of HRT boiler setting of plastic refractory as discussed by Charles Gerbig



Sketch by McMullin showing how he would convert C. W. H.'s boiler to oil firing

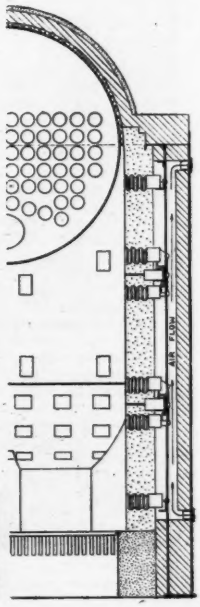


Fig. 2. Half cross-section of air-cooled furnace wall setting for C. W. H.'s HRT boiler, as discussed by Charles Gerbig

CHART OF MOTOR CHARACTERISTICS

In explanation of the chart on this page, Fairbanks, Morse & Co., in its "Catechism of Electrical Machinery," states that: "The squirrel cage induction motors, because of the wide range of electrical characteristics which it is possible to obtain, have a great variety of applications. See chart .... for a few of the common applications for the basic types. From a comparison of the operating characteristics of other loads not listed, to those listed, a very good idea of the type of motor to be applied can be obtained." Under the heading "Types of Driven Machinery," however, there are listed more than 60 different types of driven units and these nearly all are representative of driven machinery found in today's plants.

Type of Driven Machinery	Motor Type Designation	Speed R.P.M.	Approx. Starting Torque in % of Full Load Torque	Approx. Maximum Torque in % of Full Load Torque	Approx. Starting Current in % of Full Load Current	Approx. Speed Regulation % Slip	Starting Equipment	Load Conditions
Pumps (Centrifugal, Rotary and Turbine)	Type Q Ratings 5 H.P. and Smaller (NEMA Class A)	1800	180 To 225	200 To 300	600 To 750	3 To 5	Type Q Motors are capable of withstanding starting at full voltage but the starting current is relatively high and some power supply lines may require the use of reduced voltage starters.	Require normal starting torque for continuous duty. Infrequent load fluctuations. Motor provides service factor for overload conditions. Constant speed. No special conditions.
Cotton Gins Fans (Centrifugal and Propeller) Line Shafts Motor-Generator Sets Shapers		1200	160 To 200	200 To 300	600 To 700	3 To 5		
		900	135 To 180	200 To 275	575 To 675	3 To 5		
Screw Machines Planers Milling Machines Keyseating Machines Lathes Buffers Drill Presses	Type QS Ratings 7½ H.P. & larger (NEMA Class B)	1800	125 To 180	200 To 250	450 To 550	2 To 4	Type QS motors may be started across the line at full voltage with comparative low starting current. Starters may be reduced voltage or full voltage types. Manual or magnetic, non-reversing or reversing.	
		1200	125 To 180	200 To 250	450 To 550	2 To 4		
		900	115 To 140	200 To 225	450 To 550	2 To 4		
Pumps (Reciprocating and Displacement) Air Compressors Refrigerating Compressors Conveyors Stokers Crushers (without flywheels) Dough Mixers Grinders Hammer Mills Ball Mills Turn Tables Car Pullers Large Band Saws Pug Mills	Type QO Ratings 3 H.P. & Larger (NEMA Class C)	1800	225 To 275	200 To 250	450 To 550	3 To 5	Across the line, full-voltage manual or magnetic, non-reversing or reversing.	Compressors and pumps requiring less than 7½ Hp. under certain conditions may be successfully handled by types Q and QS motors. Heavy starting, continuous or intermittent duty; service factor for overload conditions.
		1200	200 To 250	200 To 225	450 To 550	3 To 5		
		900	190 To 225	190 To 200	450 To 550	3 To 5		
Passenger and Freight Elevators	Type QR (NEMA Class D)	1800	300–400	300–400	300–350	15–20	Across the line, full-voltage reversing elevator control with master switches or drives.	Require high starting torque, intermittent duty single speed reversing service.
		1200	300–400	300–400	300–350	15–20		
Hoists, Lifts, Small Cranes, Valves	Type QL (NEMA Class D Modified)	1800	300–400	300–400	325–375	15–20	Same as for Type QR.	Intermittent duty single speed reversing.
		1200	300–400	300–400	325–375	15–20		
Punch Presses, Laundry Extractor, Shears, Power Hammers, Crushers with Flywheels, Bending Rolls with Flywheels	Type QF (NEMA Class D Modified)	1800	300–350	300–350	375–450	7–12	Across the line, full-voltage, manual or automatic reversing or non-reversing.	High starting torque. Heavy fluctuating loads, usually with flywheels or high inertia to accelerate; continuous duty.
		1200	300–350	300–350	375–450	7–12		
		900	300–350	300–350	375–450	7–12		
Pumps, Fans, etc.	Type QK (NEMA Class E)	1800	75–100	200–300	650–750	2–3	Same as Type Q. Should not be started on lower than 65% tap.	Low starting torque, high efficiency continuous duty with service factor for overload.
		1200	75–100	200–300	650–750	2–3		
Pumps, Centrifugal and Turbine Blowers and Fans, Centrifugal and Propeller	Type QB 40 H.P. & Larger (NEMA Class F)	1800	75–100	150–160	350–400	3–5	Across the line, full-voltage, manual or automatic reversing or non-reversing.	Low starting and maximum torque. Low starting current. Continuous duty, service factor 1.0 and no overload capacity.
		1200	75–100	150–160	350–400	3–5		
		900	75–100	150–160	350–400	3–5		

The chart on this page was reprinted from Fairbanks-Morse, "Electric Machinery Catechism."

Pump Corrosion

(Continued from page 81)

water normally present in the ground under artesian pressure. These gas bubbles pass through the turbine unit and column pipe and undergo various changes in volume due to the changes in pressure that take place and are mechanically carried through the pump and into the column pipe.

On rapid increase in pressure the bubbles exist in the water with carbon dioxide gas at a high solution potential and as the carbon dioxide dissolves, the water film on the surface of each bubble is excessively acid due to the formation of carbonic acid. As the gas bubble with its acidic surface film passes over metal, corrosive action takes place due to carbonic acid.

This type of corrosion has been recognized at the high pressure points on the vanes in the bowls, at points inside the column pipe located from 6 in. to 2 ft above the top of the bowls and at points located several inches above the spiders between the pump shaft or shaft tube and the column pipe. The extent to which this corrosion is noted above the spiders decreases with increased distance above the pump bowls. This decrease is due to the fact that as the water moves up the column pipe, the carbon dioxide pressure within the bubbles decreases and the relative amount of corrosion decreases accordingly.

This theory also explains, in part, the reason for the more prevalent corrosion reported in the Chicago area at the present time than that formerly experienced. This is due to the fact that the static and dynamic head on the waters as they exist in the sandstones is less now than formerly and, therefore, the tendency for bubble formation is greater than was formerly. An increased tendency for bubble formation in present installations can perhaps also be explained by the fact that greater capacity pumping units are now used than formerly, creating a greater pressure drop at the suction end of the pump. These greater capacity units are not always accompanied by proper increase in column pipe or suction pipe.

The same type of corrosion takes place at shallow settings where water of high carbon dioxide content is handled. The presence of hydrogen sulfide also increases the corrosion tendency. A "worm-eaten" shaft or shaft tube is also due to this phenomena.

Corrosion May Be Caused by Stray Currents

Stray currents have been accused of causing corrosion in many cases where no other reason is evident. Perhaps this is justified and perhaps not. No thorough study has been made on this factor in pump corrosion and it is questionable whether completely satisfactory field data can ever be obtained. Some indications can, however, be obtained by measurements of possible current flow with a millivoltmeter between the discharge line and the pump head and between the column pipe and the well casing. If the potential difference is irregular it is assumed that the cause is not due to galvanic potentials but to stray currents. Any further interpretation must for the present be only theoretical and must recognize the fact that electric current takes the path of least resistance to complete its circuit or to pass from a point of high potential to one of lower potential.

Stray currents have been observed and are known to exist at many installations. It is generally a simple matter to connect a milli-voltmeter across a disconnected discharge line or from the pump head to the wall casing. To what extent they may be damaging to the pump will depend on whether the polarity is such as to enhance or inhibit galvanic action. Inhibition is included since cathodic protection is actually the application of a controlled "stray" current. As to the source of stray currents, (1) they may be transmitted from grounded lines through the distribution pipe line to the pump or (2) they may be transmitted through the earth structure to the well and pump from electrified railways or other grounded electrical power equipment.

A series of tests for possible stray currents have been made at 32 wells in Illinois. It was significant to note that the well casing was negative to the discharge pipe line or to the column pipe in 18 out of 19 cases where such potential could be measured. At about 50 per cent of the wells a varying potential difference was noted to be present between the discharge line and pump head or between the pump head and the well casing. These tests of course tell little about ground currents which exits under ground from one depth to another.

Thus far discussion has referred to direct current. Alternating current should not be overlooked since it is entirely possible for alternating current to be rectified to give a pulsating direct current. In one instance, an alternating current potention (but no direct current) was observed between the power cable conduit and the pump head. Excessive corrosion was also noted at this installation. A duplicate installation had little corrosion where the cable conduit had been left off the cable and therefore no metallic contact was present.

Stray alternating shaft currents have been noted to cause corrosion at bearings in industrial motors and generators. Alternating currents have also been proven to be corrosive to underground lead cable sheaths.

If stray currents are the cause of deterioration it should perhaps be emphasized that it is futile to experiment on the choice of metals to prevent repeated corrosion damage.

Prevention of corrosion will depend largely on the type of installation, the corrosion encountered and the economics involved. It is recognized that galvanic corrosion can be reduced by the use of all bronze bowls with bronze impellers and stainless steel impeller shaft. The additional cost over a similar installation with cast-iron bowls, bronze impellers and stainless steel shaft is in the neighborhood of 80 per cent of the turbine unit but often only about 10-20 per cent of the total cost of the installation and over a 5-year period a decided net savings should be affected (1) in power costs by a maintained efficiency, (2) by the elimination of the replacements and (3) by elimination of the costly necessity for pulling the pump.

A protected column pipe and shaft tube is almost a necessity for any deep setting. Hot-spun bitumastic (Plastex) Natasco and other coatings have proven effective. A problem still exists where wrench marks have damaged the coating on the shaft tube. Painting these fractures on the spot is the least that can be done to repair such damage and prevent accelerated attack at these points.

Column pipe protection can be obtained at an added cost of 5 to 50 per cent of the cost of the pipe itself. With regard to protective coatings in general, it is first essential that the metal surface be clean and dry before the application of any coating. It is also recognized that in general the more difficult corrosive conditions require more costly protective measures. The question of "How costly must the coating be to be effective" will best be answered by experience and correlation of cooperative data.

Methods of protection arranged in the order of their cost and effectiveness are as follows:

1. Baked-on resins.
2. Resin-base paints.
3. Chlorinated rubber.
4. Rubber-base paints.
5. Asphalt and coal tar-base paints.
6. Lead base and lead-chromate base oil paints.

It should be emphasized that an expensive coating will be of no more

The author points out that pump corrosion problems are not confined to Illinois although that is the locale where these studies were made. A recent inspection of 11 abondoned deep well turbine units showed that 7 of these had been abandoned due to corrosion, 2 due to sand erosion, and one due to obsolescence while the last was apparently as good as new. These pumps had been removed from wells geographically distributed over the midwest.

value than a cheap coating if the pipe is not clean and dry during the application.

Several cathodic protection installations have been made in Illinois. These have involved the use of an auxiliary electrode at the suction pipe and forcing a small current through it and using the whole pump unit as a cathode for the return of current to the surface where it is tapped off the pump head, the head shaft, and in some cases off the well casing. A special arrangement is provided to make the lower end of the impeller shaft and the bowls of equal potential.

The insertion of insulation between the discharge line and the pump head is being used to inhibit or prevent stray current electrolyses. In some installations the well casing is also insulated from the pump head and column pipe. Where such potective measures are installed it is imperative that the housing for the power cables and the return water lines for water lubricated pumps should also be insulated from the pump head or the efforts will be nullified.

Acid Treatment

With regard to efficiency of operation, many pumps have been inspected which were coated and even filled with an accumulation of iron oxide in the bowls and sometimes in the impellers. In one installation a deposit of calcium carbonate of one-half inch thickness was present in the discharge pipe. The sources of such deposits are questionable. There is good evidence that a large portion of the iron deposits are due to an accumulation of corrosion product from the bowls. These bowls appear to retain their original shape but careful inspection will nearly always show the cast-iron surface to be softened or graphitic.

Such deposits naturally reduce efficiency of operation and for deep settings it is costly to remove by pulling the pump. It is entirely feasible to clean such deposits and increase the efficiency of operation by treating these pumps in place with inhibitied hydrochloric acid.

This discussion has been brief throughout. Many points have not been covered throughly and much can be said concerning the value of plus or minus five or ten per cent efficiency with regard to dollars per million gallons of water. The author wishes to express his sincere appreciation to Millis for collecting much of the data presented.

The Press-Temp Boiler Feed Cycle . . . . . .

Designed to prevent flashing and cavitation when boiler feed pump takes suction from direct-contact heater, available submergence is limited, available net positive suction head is reduced . . . Press-Temp* cycle uses heat exchanger to sub-cool water flowing from heater . . . In this manner, surplus NPSH is obtained, as shown by curves

By
IGOR J. KARASSIK
Application Engineer, Worthington Pump & Machinery Corp.

DEVELOPMENT of the Press-Temp boiler feed cycle was directed towards the solution of the problems that arise when the boiler feed pump takes its suction from a direct-contact heater and where the available submergence is extremely limited.

The required NPSH, or net positive suction head, is the energy in feet of the liquid pumped which must be made available over and above the vapor pressure of the pumped liquid, in order to avoid vaporization, flashing and cavitation in the centrifugal pump impeller. For a given set of operating conditions of capacity and head per stage, the required NPSH is a function of the operating speed, increasing with higher speeds and decreasing at low speeds.

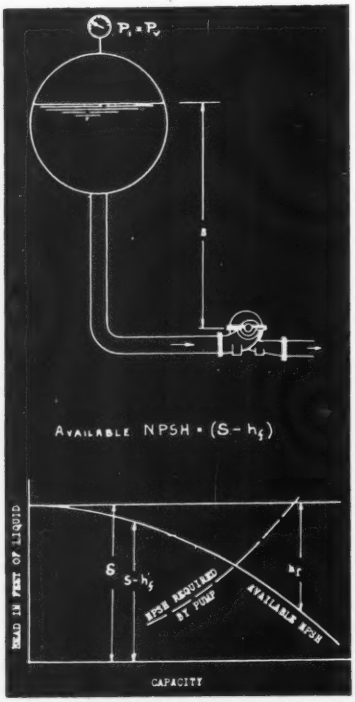


Fig. 1. Relations between available and required NPSH, static head and friction losses in suction piping

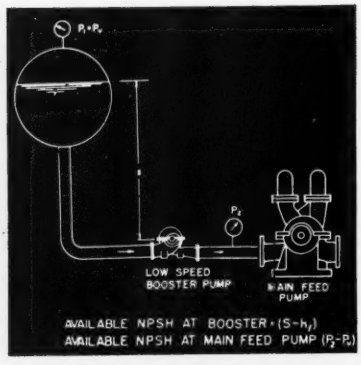


Fig. 2. How available NPSH at suction of boiler feed pump may be substantially increased by use of a booster pump

The available NPSH of a system, on the other hand, is the difference between the suction pressure and the vapor pressure, and can be expressed:

$$\text{Available NPSH} = (P_1 - P_v) + (S - h_f)$$

where:

- P_1 = Pressure in the suction vessel
- P_v = Vapor pressure at the pumping temperature
- S = Static elevation from suction vessel water level to pump centerline
- h_f = Friction losses in the suction piping

Then, if H_s is the required NPSH for the boiler feed pump, proper operation of the pump will only be insured if:

$$(P_1 - P_v) + (S - h_f) \geq H_s$$

In a direct-contact heater, the pressure P_1 is substantially equivalent to the vapor pressure P_v, therefore, the only available NPSH is represented by the difference between the static head S and the friction losses h_f, as illustrated in Fig. 1. It is apparent that, in many cases, physical limitations reduce the value of S to a nominal amount while, on the other hand, the desire to utilize the highest per-

*Patent applied for. All re-publication rights reserved by author.

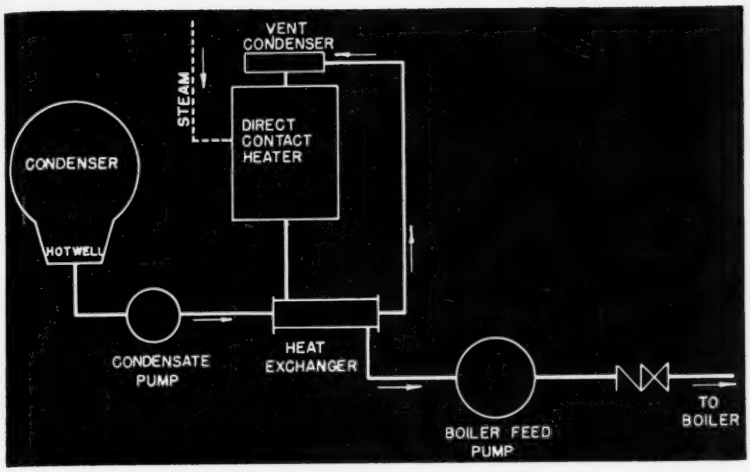


Fig. 3. Schematic diagram of the Press-Temp boiler feed cycle, in which heat exchanger reduces temperature of water flowing to feed pump suction, thus increasing available NPSH

missible operating speed increases the required NPSH substantially.

One Method: Booster Pump

In such cases, the installation may include a low-speed, low-head booster pump which can operate under the available suction conditions and which delivers the feedwater under moderate pressure to the suction of the main feed pump, as shown in Fig. 2. The available NPSH at the suction of the latter is increased substantially and the main feed pump can be selected to operate at the most suitable speed, without regard to the low available submergence from the heater. However, the inclusion of a booster feed pump in the cycle presents certain very definite disadvantages. It increases materially the original cost of the installation, requires an additional driver and introduces additional maintenance problems.

How Press-Temp Cycle Does It

Referring to the formula expressing the available NPSH of a system, the Press-Temp cycle is based on a reduction in the value of P_v, instead of an increase in that of P_1, which is what is accomplished by the inclusion of booster feed pumps.

While the feedwater issuing from the direct contact heater is at a pressure substantially equivalent to the vapor pressure corresponding to its temperature, it is quite feasible to interpose a heat exchanger in the suction line between the direct-contact heater and the boiler feed pump itself. Once the value of the required NPSH becomes established for the pump selected, the difference between this NPSH and the available NPSH $(S - h_f)$ must be made up by subcooling the feedwater to a temperature lower than that in the direct-contact heater. Then:

$$\text{Available NPSH} = (S - h_f) + (P_{v_1} - P_{v_2})$$

where:

P_{v_1} = Vapor pressure at temperature in the direct contact heater

P_{v_2} = Vapor pressure at temperature at outlet of heat exchanger

Since the available NPSH must be equal to or greater than H_s (the NPSH required by the pump):

$$(P_{v_1} - P_{v_2}) \geq H_s - (S - h_f)$$

In order to avoid heat losses in the feedwater system, the Press-Temp cycle contemplates the use of the condensate from the condensate pump discharge as the cooling medium in the heat exchanger. The cycle is described schematically in Fig. 3.

Use of Heat Exchanger

It will be seen that the condensate pumps discharge through a closed heater or heat exchanger, before proceeding into the direct-contact heater. The feedwater from the direct contact heater, in its turn, is cooled on its passage through this heat exchanger before entering the boiler feed pump. The heat exchanger is arranged in such a manner that the condensate discharge flows through one or more bundles of tubes, while the feedwater from the direct-contact heater flows through the heat exchanger shell, around the tubes. This arrangement is selected to minimize the friction losses through the heat exchanger as far as the feedwater flow to the boiler feed pumps is concerned.

In some cases where space is at a premium, it is contemplated that the heat exchanger would be located inside the storage space of the direct contact heater, this storage space being properly baffled to provide for satisfactory flow of the feedwater past the tube bundles.

How Much Is Gained?

The effect of sub-cooling on the available NPSH is illustrated in Fig. 4, where the surplus NPSH obtained by means of temperature depression is plotted against the initial feedwater temperature for a series of values of temperature depression.

In using this chart, it is only necessary to know the initial feedwater temperature in the direct-contact heater and the required surplus NPSH to determine the necessary temperature depression. For example, if the initial feedwater temperature is 325 F and it is required to provide 20 feet of surplus NPSH, the necessary temperature depression will be 6 F, or, in other words, the feedwater at the outlet from the heat exchanger must be reduced to a temperature of 319 F.

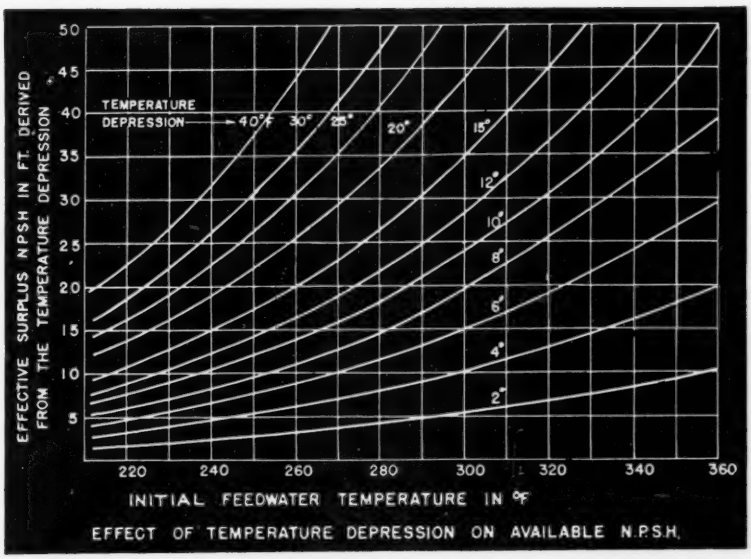


Fig. 4. Effect of temperature depression on available NPSH, as carried out in Press-Temp cycle

Why Design Details Are Important in Motorized Control Valves

By **S. D. ROSS** Engineer, Brown Inst. Co., Div. of Minneapolis-Honeywell Regulator Co.

AS WAS EXPLAINED in the first installment of this article in the August issue, a motorized control valve assembly comprises two essential elements; a power unit which is operated by a controller to position a sliding stem in accordance with a controlled variable and the control valve itself. The power unit was considered in the first installment; now, the control valve will be considered.

The Control Valve

Sliding stem control volves for use with either electric or pneumatic power units are in most cases identical in design. The most common type of body for these valves is the globe body illustrated in Fig. 4, comprising: (1) stuffing box, (2) inner port with valve seat, and (3) inner valve or valve plug which is directly attached to the valve stem.

Bodies of this design are identical in the smaller sizes for two-position and proportional control, differences in design for the two types being incorporated in the power unit. In the larger sizes, however, the additional travel of the high lift throttling valve requires a marked increase in body dimensions as compared to the low lift valve.

Stuffing Box

The stuffing box functions to seal the fluid flowing through the valve body, while permitting the valve stem to pass through as freely as possible. As shown in Fig. 4, it is mounted on the top or head flange of the valve body and has a sealing gland around the valve stem which is packed with composition rings or other suitable material. The space around the packing is filled with a lubricant selected to suit the fluid being sealed.

A gland nut is provided at the top of the sealing gland to permit access to the chamber and provide a means of tightening the seal by compression on the packing material. Inasmuch as this chamber can be the most serious cause of friction on the valve stem, the packing and lubricant for most fluids should be such that an adequate seal can be obtained by hand tightening of the gland nut.

The valve stem passing through the stuffing box must be of sufficient diameter to insure a sturdy connection to the power unit stem, yet not of excessive size to create undue friction against the packing. To further promote free action, the stem is highly polished.

Valves for proportional control and sometimes valves for two-position control are supplied with a stem lubricator on the stuffing box as shown in Fig. 4. By means of a jack screw, additional lubricant can be forced into the packing gland from time to time and the seal thereby kept tight. Excessive friction may be caused in the stuffing box if sufficient lubricant is not maintained around the valve stem, but may also be caused if the jack screw is tightened too much in an attempt to stop leakage.

If fluid in the valve body is under high pressure, a shut off valve on the stem lubricator (shown on Figs. 2 and 5) is furnished to prevent possible blowing out of the fluid through the stem lubricator when the jack screw is removed to renew the lubricant.

Temperatures of fluids above 500 F cause excessive drying of the lubricant. For such applications an extension bonnet (see Fig. 5), with stuffing box incorporated at the top and radiating fins along the length, is used so that heat is readily dissipated.

Temperatures of fluids below 32 F thicken the lubricant, thereby increasing friction. Also, ice tends to form on the portion of the valve stem extending from the stuffing box, causing the stem to stick if it remains long in one position. For such applicautions a plain extension bonnet without radiating fins is used so that ice coating on the bonnet can be removed easily, and heat can be absorbed from the surrounding atmosphere.

For especially corrosive fluids, such as hydrofluoric acid, the extension bonnet type of assembly can be furnished with an additional sealing gland just above the connection to the head flange. This gland is a labyrinth of close fitting steel packing rings into which a sealing fluid is introduced through a side tap on the bonnet just above the gland. Pressure of the sealing fluid is maintained in excess of the fluid pressure at the valve body to prevent leakage of the corrosive fluid around the valve stem and through the stuffing box to atmosphere. The usual stuffing box acts to prevent leakage of the sealing fluid.

Inner Port

The inner port is the opening within the valve body into which the valve plug seats to throttle the flow. Valve bodies, as illustrated in Figs. 4 and 5, are available in single or double port construction. In order to explain fully the general function of the inner port and inner valve combination, and the design considerations involved, the basic factors of flow through the inner port will be discussed.

THEORETICAL CONSIDERATIONS: The fundamental equation of flow through an orifice may be expressed as follows:

$Q = A\ C\ \sqrt{2g\Delta p}$, where in suitable units:

- Q = rate of flow through the orifice
- A = area of the orifice
- C = orifice constant
- g = acceleration due to gravity (a constant)
- Δp = differential pressure (upstream less downstream pressure at the orifice)

While other properties of the fluid (flowing) must be taken into account for a given valve passing a given fluid, this basic equation will serve for the present considerations.

The orifice constant "C" may be dismissed as representing a factor less than unity which takes into account the decrease in flow from the theoretical value caused by turbulence and change in direction of flow through the valve body. This coefficient is empirical, varying greatly with the valve body construction and the rate of flow.

When the valve plug is in the fully open position, all or most of the inner port will be uncovered, and fluid will flow through the opening in accordance with the basic flow equation. With "C" at some constant value for the open valve position, if the control valve is to assume full control of flow, "A" in the equation should represent the free area and "Δp" the differential pressure across the inner port. Under these conditions, "Q" will represent the true maximum capacity of the valve.

The area of the inlet or outlet passages of the valve body, or the pipe line area, therefore should not be less than the area of the inner port, because the capacity flow of the valve would be limited by the smaller area. The flow would reach a maximum value before the valve plug reached its full open position and in proportional control the valve could not provide control beyond this point.

Experience has shown, moreover,

Part II. In the first part of this article in the August issue, the author analyzed the design and construction of the two types of power units—the electric type and the pneumatic type—used with motorized control valves of the sliding stem type. Now, in this installment, he shows why the design of the control valve itself is important in the proper selection of valves and in the operation of an accurate control system

that the discharge or outlet passage of the valve body should be increased in area to decrease the pressure loss in the valve body due to turbulence and change in direction of the fluid leaving the inner port. This effect is more evident in the double port body which has two discharge passages. The less this pressure loss, the greater the capacity of the valve body.

The basic flow equation also shows that with "A" a maximum for the fully open valve the pressure differential (Δp) across the inner port of the valve determines the capacity. This pressure differential is considered constant in calculating the capacity; but is difficult to maintain constant, being a function of the source and the end pressure of the process, less the variable pressure loss in the piping system. This relationship should serve to emphasize the need for accurate data on the pressure conditions at the valve.

Another general consideration in the inner port design is the inner valve seat. This may be cast integrally in the valve body, being then merely a ridge around the port opening, or it may comprise a separate ring which is screwed into threads on the inner port. The advantages of the latter are: (1) worn seat rings can be renewed, (2) the seat can be fabricated from more durable metals without requiring that the whole body be constructed of this material, and (3) the inner valve and seat can be replaced by a matched pair of a different size, should the valve be found too large or too small when installed.

Direct and Reverse Action

A characteristic common to single and double port valves is the action of the valve plug to seat downward to close (Fig.4) or upward to close. There is need for the two actions only when the valve is operated by a diaphragm motor, which generally moves the stem downward with increase in air pressure. In the event of air failure, the application sometimes requires that the diaphragm motor valve assume a closed position and sometimes an open position.

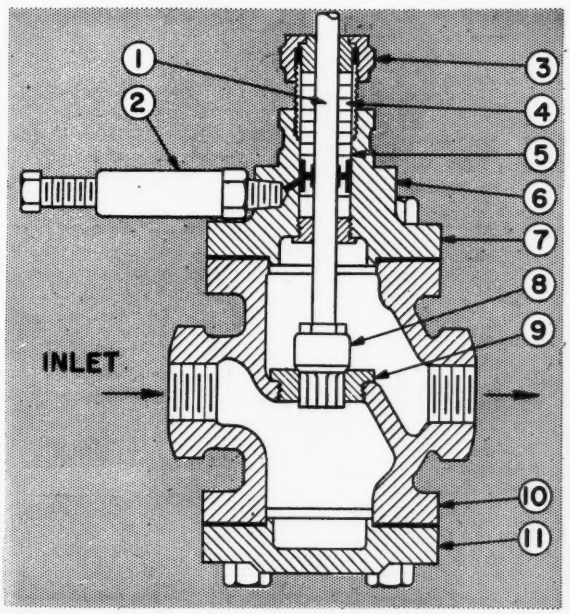
Downward motion of the valve plug to close the valve is known as direct acting, air-to-close, or spring opened (upon air failure). With the valve plug inverted and upward motion of the valve plug to close, the valve is known as reverse acting, air-to-open, or spring closed. Most pneumatic controllers have provision for direct or reverse action and can be changed easily to provide the correct action required for the control valve action selected.

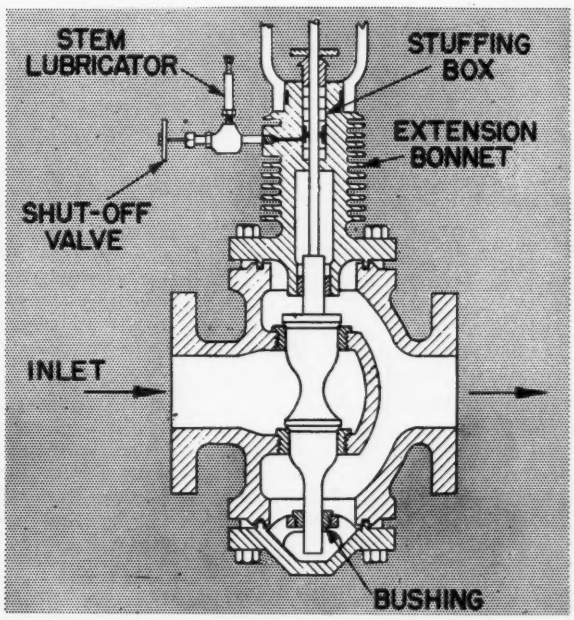
For purposes of standardization and possible field conversion, most valve bodies are designed with head and blind flanges of the same size so that the valve body can be inverted and the valve plug reversed in position on the valve stem to reverse the action of the valve.

Both direct and reverse acting valves are not required for most electric motorized valves, because the common types require electric power to move in either the open or closed direction, and reversal of operation is accomplished by interchanging of leads to the motor terminals. It will be noted with electric motorized valves, other than the spring return type, power failure results in the valve remaining in the last position attained prior to power failure.

SINGLE VERSUS DOUBLE PORT BODIES: In all sliding stem type control valves,

Fig. 4, left, below: Single port body with bevelled disc inner valve. (1) valve stem; (2) stem lubricator; (3) gland nut; (4) packing; (5) sealing gland; (6) stuffing box; (7) head flange; (8) inner (bevelled disc type); (9) removable seat ring; (10) valve body; (11) blind flange. Fig. 5, right, below: Double port body with ratio plug inner valve and finned extension bonnet





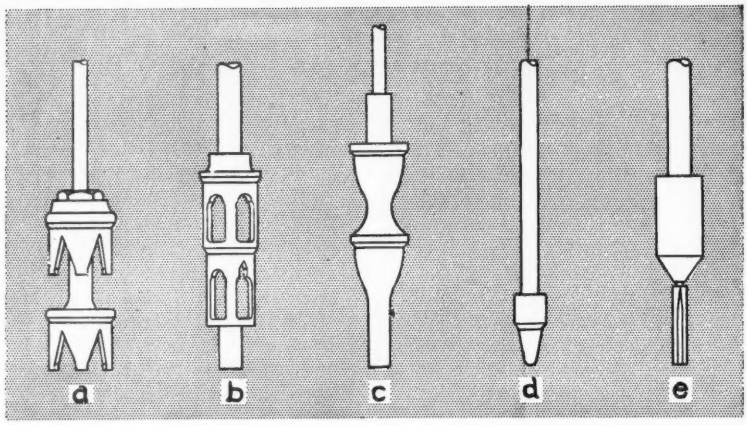


Fig. 6. Various inner valves for proportional controllers

fluid pressure in the valve body creates a vertical thrust on the inner valve. This force is the product of the differential pressure across the valve multiplied by the free area of the valve plug normal to the stem motion.

Single Port Valves

In single port valves differential pressure acts over the entire bottom of the valve plug (see Fig. 4) to create an upward force on the valve stem. When the valve plug is in the closed position, moreover, the downstream pressure in many applications drops practically to zero, thereby increasing the pressure differential so that the upward thrust may constitute an appreciable force. The power unit must overcome this force to hold a direct acting valve closed, or to open a reverse acting valve. For proportional control with diaphragm motor valves, the effect of stem thrust is obviously undesirable and, except for small valve sizes, usually prohibits the use of single port bodies.

The double port body was designed to minimize the undesirable effects of this thrust. The inlet and outlet flund pressures tend to balance themselves by acting both upward and downward on the two valve plugs, resulting in what is termed a balanced valve (see Fig. 5). For practical construction the upper port is usually made slightly larger than the lower, so that the lower valve disc may pass through the upper port when the inner valve is installed. The valve is then called semi-balanced but is actually about 90 per cent balanced, with some 10 per cent of the differential pressure creating an upward stem thrust when the valve is closed.

Thrust Changes

When the inner valve is moved off its seat, however, the stem thrust changes. In the case of one double port valve with V-port inner valve the thrust was found to decrease gradually from a maximum upward value when the inner valves were on their seats to a small value in the reverse direction at about 75 per cent of travel, and then to increase gradually in the upward direction again toward the end of stroke to a value about one-half that at the closed position.

This variation in stem thrust with the inner valve position is attributed to the changing velocity effect of the fluid impinging upon the valve plug or plugs. When the valve is in the closed position, the thrust is due only to the static pressure of the fluid and remains constant. This latter value, however, is the maximum, and with double port valve bodies does not constitute an appreciable force unless high pressure differentials are present.

The double port construction, however, has one disadvantage. With variation in temperature, the stem portion connecting the two valve plugs contracts or expands linearly a different amount than the valve body. In the closed position, therefore, one valve plug seats first and prevents the second plug from seating completely. This results in a minimum or "leakage" flow, varying from 1.5 to 4 per cent of the maximum flow through the valve. For tight shut-off, as sometimes required, a single port valve must be used.

Inner Valve

Inner valves fall naturally into two classifications, according to the type of control for which the valves are to be used, that is: two-position or proportional control. There are, however, several design features common to both classifications.

General Requirements: One consideration common to all inner valves is the effect of thrust due to fluid pressure against the valve stem and plug in the direction of flow through the valve. Such a thrust is of particular consequence at higher velocities of flow—causing misalignment of the valve stem and thereby changing the relation of the inner valve position with respect to the valve seat. This is an effect undesirable in a proportional control valve, particularly when the inner valve approaches the closed position, because of its effect on the rate of flow. Misalignment of the valve stem also increases friction in the stuffing box as a result of binding of the stem against its bushings and the packing.

Thrust is prevented from affecting the stem alignment by means of skirted guides on the inner valve (see Fig. 4), or by an extension stem on the bottom of the inner valve with a guide bushing in the blind flange (see Fig. 5).

Even with skirted guides or a bottom extension stem, however, it is evident that some friction will result from line thrust pressing the skirt against the valve seats or stem against its bearing. The construction of the valve body shown in Fig. 2 is designed to reduce such friction to a minimum. The plan view illustrates clearly how inlet flow is divided equally to act against the inner valve from opposite directions, thereby tending to balance itself. This refinement of design is confined to the proportional control valve.

Another general consideration is the connection between the inner valve and valve stem. First of all, the joint should permit easy removal of the inner valve for replacement or reversal of valve action. In addition, it is sometimes made flexible to permit a slight sidewise motion of the valve plug so that the latter may be properly aligned in its seat. This is particularly desirable with the double port valve construction wherein two plugs should seat. The single bearing connection of the diaphragm motor (see Fig. 2), however, permits sidewise motion in the power unit, so that the valve stem connection to the inner valve may be rigid.

Prevents Stalling of Motor

In the case of electric motorized valves, the stem connection is sometimes designed to provide some overtravel of the stem and assure tight seating. This is accomplished by placing a small compression spring, in a suitable retainer, between the bottom of the valve stem and the top of the inner valve. This arrangement also prevents stalling of the motor should particles of a foreign substance lodge on the valve seat, preventing the valve stem from moving to the end of travel.

Inner Valves for Two-Position Controls: For such control the inner valve is simply a flat disc bevelled at the seating edge. This construction best provides as maximum flow in the open position, with a minimum lift. Several types, also called quick opening or poppet inner valves, are available—such as the metal bevelled disc with skirted guides, illustrated in Fig. 4, or a type with removable composition disc on the seating surface.

The disc of the latter is made of a resilient material having the advantage of providing tight sealing, re-

gardless of whether particles of dirt or other hard matter become lodged between the seat and the valve disc. It is suitable for air, steam, or water —provided these fluids do not contain corrosive impurities. The life of this disc, of course, can not compare with the metal disc, especially at higher fluid temperatures, but the disc is easily replaceable.

INNER VALVES FOR PROPORTIONAL CONTROL: The chief types of inner valves for such control may be classified as follows:

1. V-Port Types
   a. With skirted guides (Fig. 6a)
   b. Cylindrical with bottom guide (Fig. 6b)
2. Shaped Plunger Types (with bottom guide)
   a. Ratio Plug (Shown in Fig. 5)
   b. Throttle Plug (Fig. 6c)
3. Low Flow Rate Types
   a. Needle Valve or Tapered Plug (Fig. 6d)
   b. Special types for very low flows

By design of the inner valve shape, many different relationships between flow and valve lift are obtainable. In certain applications, a prime concern is the choice of an inner valve with a particular "flow-lift" characteristic to suit the process. The following discussion, however, is limited to physical characteristics of the inner valves.

The V-Port Inner Valve of Fig. 6a comprises a skirt guide in which "V" or similarly shaped ports are cut such as to create increasing areas of opening for each succeeding unit of lift. The port openings are usually standardized to one shape in manufacture.

One advantage claimed for this design over the shaped plunger types is its ability to operate continuously over long periods of service with minimum erosive action on the surfaces controlling the rate of flow. Such erosive action which does occur is said to take place on the outer edge of the ports next to the valve seat and not seriously alter those portions of the V-port which control lower rates of flow.

The Cylindrical Type of V-Port Inner Valve shown in Fig. 6b is basically the same as the skirt type, but it will be noted that a rectangular portion is provided in the upper port for inlet of the fluid to the shaped portion and in the lower port for outlet of the fluid from the shaped portion. Thus total lift occurs with this type over only a part of the ports.

The Shaped Plunger Types illustrated in Fig. 5 and 6c are seen to be fundamentally the same. The terms ratio plug and throttle plug, respectively, have originated to differentiate the two which have very different flow-lift characteristics.

The chief disadvantage of these types is that low clearance flows are more difficult to maintain because of the "nozzle orifice" effect around the periphery of the port as compared to the straight edge openings in the V-port types. This effect causes excessive erosion or "wire drawing" at low percentage rates of flow, particularly with high pressure differentials, and thereby increases the clearance flow.

Formed plungers offer the advantage, however, that they may be made from materials suitably heat treated for unusually severe conditions of operation. They are also simpler to shape in manufacture.

Inner Valves for Low Flow Rates are designed to provide the necessary smaller port area changes which cannot be obtained with the previously described inner valves. A common type shown in Fig. 6d, known as a needle or tapered plug inner valve, is available with inner port diameter as small as ⅛-in. A valve with this type inner valve may have a capacity, for example, of ⅓ gpm of water with about a ½ psi pressure drop, or 3⅓ gpm with about a 60 psi pressure drop. The increased application of control valves for still lower flow rates, such as encountered in pH control, has led to the development of other designs of inner valves too special to be covered in this article.

Materials of Construction

In addition to the physical characteristics of the control valve, there remains the important consideration of selecting suitable materials for the valve body and its internal parts. Temperature, pressure, erosiveness, and corrosiveness of the fluid being handled are factors which determine this choice. It is obviously imperative that the properties of the fluid to be handled are known, so that the proper materials of construction can be selected.

Valve Body Materials

Valves bodies are made chiefly from bronze, cast iron, cast steel, and stainless steel—with many variations in the proportions of the alloying constituents and other special alloys being available to suit unusual conditions.

The inner valve, valve seats and valve stem, however, may be made from a metal different from that of the body itself to counteract erosion or corrosion. This is known as the valve trim. Common trims are: bronze for bronze and cast iron bodies; and stainless steel for bronze, cast iron, cast steel, and stainless steel bodies. Other trims are available to meet special requirements.

Where temperature and pressure alone are considered, the valve body is selected on the basis of the commonly accepted American Standards Association ratings. The tables below summarize these ratings for standard valve bodies.

Table I. Bronze or Cast-Iron Bodies

Pipe Connection	Working Pressures psi at 410 F	psi at 100 F
Screwed Ends	250	400
Standard Flanged ...	*125	175
Extra Heavy Flanged	250	400

*125 PSI at 360 F.
100 PSI at 340 F for valve sizes over 5 in.

Table II. Cast Steel or Stainless Steel Bodies

Pipe Connection	Working Pressures psi at 750 F	psi at 100 F
Screwed Ends	600	1000
150 lb Flanged.....	†150	230
300 lb Flanged.....	300	500
400 lb Flanged.....	400	670
600 lb Flanged.....	600	1000
900 lb Flanged.....	900	1500
1500 lb Flanged.....	1500	*2500

†Rating at 500 F.
*Rating for Cold, Non-Shock fluids.

Although screwed or flanged ends are the common types of pipe connections on valve bodies, special joints—such as "tongue and groove, ring and ball" joints— are sometimes used to provide a tighter seal against liquids which tend to leak through the more common joints. The names of these connections are indicative of their nature.

Where erosion due to the velocity effect and nature of the fluid flowing is of prime concern, a hard surface may be imparted to the seat rings and inner valve by means of Stellite facing, which is deposited by welding. This special coating is hard even at red heat and usually is available only in valves with stainless steel or similar alloy trims. Stellite facing is commonly used to prevent erosion or wire drawing due to high velocity steam.

The subject of corrosion resistance of various valve metals is complex and entirely beyond the scope of this article, but references are given in the bibliography. Many metals have excellent resistance to corrosion but are not satisfactory for valves because of initial cost, difficulty in machining, or physical properties undesirable to the finished product. It is of interest to note that control valves of ceramic and glass construction are also available, finding application where it is desired to prevent contamination of the fluid being handled.

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Boiler Water Conditioning at West Point Power Plant

Colloidal treatment without inorganic salts described as a development of years of research and experimentation . . .Colloidal dimensions measured in millimicrons . . . Physical principles of adsorption and coagulation prevent scale formation and corrosion of boiler metal . . . Colloidal action works to remove old scale, reduces blowdown requirements and foaming tendencies . . . Results of experience with all-colloidal emulsion in West Point power plant are summarized

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GENERALLY, engineering research must necessarily be followed by actual practical application in the field without which no actual progress is possible. This is particularly true of research and development in water treatment. Collaboration by operating personnel, engineers and chemists alike, as well as management, over a period of time will bear out whether and to what extent a development is really meritorious. This article deals with just such a development, describing its theory as well as its actual application, and it is hoped that information contained herein will be of concrete advantage to all individuals concerned with water treatment for steam generating equipment.

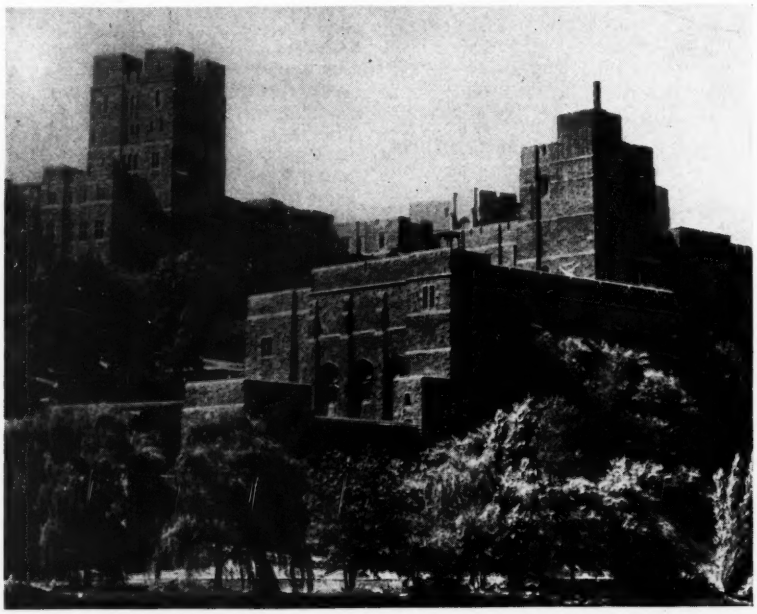


Fig. 1. Exterior view of West Point Power Plant (Note stack at upper right in photograph)

A SURVEY of the existing literature on water treatment methods shows an abundance of articles on the use of the various inorganic chemicals such as phosphates, alkalies, etc., for internal boiler water treatment or for pre-treatment purposes, and by comparison, few articles on the addition of colloidal agents such as the tannins to these inorganic chemicals. Relatively recently, there has been a specific interest in this latter method due to a desire to achieve better results than have been obtained with the use of the inorganic treatments alone. In recent years, there has been increasing interest in a third method which is the logical outgrowth of dissatisfaction with conventional conditioning methods: namely, straight colloidal conditioning without the use of any inorganic chemicals at all.

Early Attempts at Water Treatment

In the early days of water treatment, prior to the application of any scientific study, many available materials such as potatoes, oat hulls, molasses, tannins, seaweed, etc., were in common use. Despite instances of success here and there, due probably to a combination of fortunate circumstances caused by the particular water in use, the particular boiler and some organic constituent of the particular treatment used, it was nevertheless readily apparent to boiler operators that the problem of water treatment was still largely unsolved.

The three basic difficulties the treatment sought after had to correct were:

1. Deposition of incrustants on heating surfaces as scale.
2. Deterioration of metal due to corrosion.
3. Delivery of a wet, carryover laden steam with its attendant evils.

Use of Inorganic Chemicals

Study led to the introduction of the internal use of the various inorganic chemicals such as soda ash, caustic soda, sodium sulfite, the various phosphates, all sodium compounds and, today, the corresponding potassium salts for high temperature operation. In addition to the development of the internal treatments, various external-to-the boiler or pre-treatment systems were devised such as the lime-soda (hot or cold) treatment, lime-phosphate treatment, zeolite softener (hydrogen or sodium cycle), and, more recently, the various resinous exchangers.

All these methods, whether internal or external, are based upon the inorganic chemical reaction principle by means of which a supposedly harmless compound is formed in place of the original harmful hardness constituent.

Use of the Inorganic-Organic Chemical Combination

In many instances it has been found that even with rigid chemical control, proper water conditioning results were not being obtained with the use of inorganic chemicals alone. Remembering the early days of water treatment when organic substances were in use, with some measure of success, an attempt was made to utilize such materials in conjunction with inorganic chemicals. Again, experience has shown that though improved results may be obtained by using an inorganic such as phosphate, with an organic such as tannin, the answer to proper water conditioning

does not lie wholly in such combination. In fact, it has been shown that the organic ingredients act on the inorganic chemicals and vice versa with the result that they interfere with each other's actions, yielding results only moderately better than when they are used alone.

The mechanism involved when using the inorganic chemicals is the grain for grain or chemical reaction principle based upon rigid chemical control. On the other hand, the partial success exhibited in the use of "naturally" occurring materials such as seaweed or tannins, is based upon the fact that these materials consist in part of "colloidal" matter. It is the presence of this truly colloidal matter in the seaweed or tannin which causes them to exhibit partially successful water treatment properties. The action of these colloids is not dependent on chemical reaction in any way.

Colloidal Organic Treatment

In order to appreciate the properties of colloids, it is necessary to examine their physical relationship to other materials. Matter of colloidal dimensions can be produced, in the simplest sense, by taking an object and subdividing it repeatedly until its component parts reach the tiny size range between 1 and 100 millimicrons. To illustrate the tremendous surface area obtained when subdividing matter into such small dimensions, it has been calculated that if a piece of graphite weighing 1 gram were ground to colloidal dimensions, there would be a resultant surface area on the particles of 1173 sq ft. This illustration of the presence of the enormous surface area when dealing with colloids is of prime importance since the colloidal properties are the result of the presence of what is termed "surface phenomena." An examination of Fig. 2 (Table of Dispersion) shows the relationship of colloids to suspensions and true solutions.

Whereas the inorganic chemicals function on a reaction basis which can be considered a grain for grain chemical reaction, the colloid owes its water treating characteristics to its two major surface properties of adsorption and coagulation. Adsorption may be defined in the water treatment sense as an ability to fix itself to materials by exhibiting a sheathing action. This is illustrated in Fig. 3 where the colloid, instead of reacting with the scale forming impurities present in the water, simply sheathes or coats these impurities the instant they emerge as tiny, crystalloid particles. By the agglomeration of several tiny sheathed impurities, a coagulated gel is formed as a flocculant, non-adhering sludge particle which remains suspended in the boiler water until it acquires sufficient weight to gravitate downwards, being thus eliminated with the blowdown. The adsorptive capacity extends not only to the impurities such as the calcium and the magnesium salts, but also to silica or suspended impurities which may at times enter with the feedwater.

Old Scale, Blowdown and Foaming

A colloidal conditioner also has the ability to fix itself as a fine, micronic, almost completely heat conductive film on the boiler surfaces, which it is in contact with at and below the water line, thereby not only offering a "slip-surface" preventing the adherence of scale, but also affording protection against the corrosive attack of acidic substances and also oxygen and carbon dioxide. At the same time, in addition to the adsorptive sheathing property described previously in connection with the removal of scale forming matter, there is also a sponge-like activity by the colloidal gel in that it can adsorb oxygen or carbon dioxide, effecting their removal in the gel formed. Thus, we see that corrosion control is provided in two-fold fashion, namely, by film formation and adsorption. With proper organic colloidal conditioning, the film formation and gas adsorptive action provide protection against corrosion. The boiler water builds up to and maintains a natural pH value based on the original characteristics of the feedwater and requires no alkaline chemical dosing. The activities of the colloid are illustrated in the series of diagrams in Fig. 4 where the adsorptive and sheathing action on scale-forming materials, the adsorbing of the free gases and, finally, formation of the coagulated gels which settle, is shown.

"... colloidal dimensions can be produced by taking an object and subdividing it repeatedly until its component parts reach the tiny size range between 1 and 100 millimicrons."

Though the primary function of a good water treatment is to prevent the formation of new scale, there is often the necessity to alleviate a scale condition caused by previous lack of proper treatment. The properly developed organic colloid does not attack scale deposits chemically. It is designed to safely and slowly disintegrate deposits in a purely physical fashion to minimize the evils of too rapid scale removal. Since the colloidal particles are micronic in size they have the ability to infiltrate the scale's surface layer no matter what its composition, and by a purely mechanical swelling action slowly disintegrate it. The resultant sludge and cracked scale is then eliminated with the blowdown and proper boiler washing.

A solution to excess blowdown can be found in the use of the proper organic colloid alone. The solids content of the colloidal emulsion is so low that no appreciable increase in the boiler solids takes place when it is added to the boiler water. Then, by means of the gel formation action and subsequent agglomeration and flocculation, the suspended matter tends to gravitate downwards. Thus, when the blowdown valve is opened, in addition to the proportional removal of dissolved solids, there is a correspondingly large discharge of suspended matter due to the weight and nature of the particles. Since

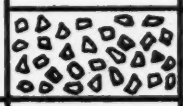
	SUSPENSIONS	COLLOIDS	SOLUTIONS (MOLECULAR)
			
VISIBILITY OF PARTICLES	By eye or through microscope	Through ultra-microscope	Undetectable even through ultra-microscope
DIAMETER OF PARTICLES	Greater than 100 millimicrons	From 1 millimicron* to 100 millimicrons	Below 1 millimicron
EXAMPLES	Sand in Water Milk of Magnesia	Starch Glue	Sugar in water Salt water

Fig. 2. Table of dispersion which shows the relationship of colloids to suspensions and true solutions

*1 Millimicron = 1 ten millionth of a centimeter

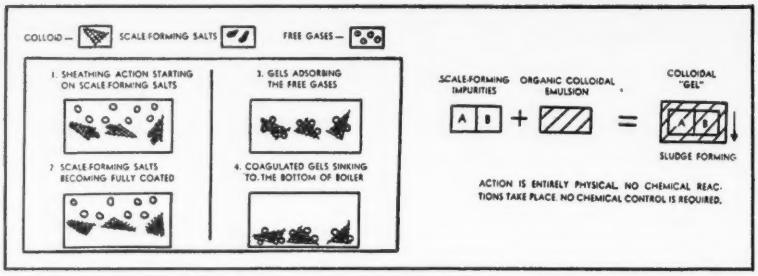

COLLOID—
SCALE FORMING SALTS
FREE GASES—
1. SHEATHING ACTION STARTING ON SCALE FORMING SALTS
3. GELS ADSORBING THE FREE GASES
2. SCALE FORMING SALTS BECOMING FULLY COATED
4. COAGULATED GELS SINKING TO THE BOTTOM OF BOILER
SCALE-FORMING IMPURITIES
ORGANIC COLLOIDAL EMULSION
COLLOIDAL "GEL"
SLUDGE FORMING
ACTION IS ENTIRELY PHYSICAL. NO CHEMICAL REACTIONS TAKE PLACE. NO CHEMICAL CONTROL IS REQUIRED.

Fig. 3. Organic colloidal action. Fig. 4 (right). Graphic illustration of colloidal action.

there is this efficient removal of suspended matter when using the organic colloid, not only can the blowdown volume be low with low heat loss, but as a corrolary, high boiler water concentrations can be carried with safety.

The activity of colloidal matter previously described results automatically in a specific anti-foam effect. Initially, addition of the organic colloid to the boiler water has no appreciable effect on the solids content, then the removal from the surface layer of suspended matter and subsequent gravitation of the flocculated gels downward removes the important contributing factor in foaming. Naturally, where mechanical features such as a condition of inadequate steaming space, carrying of too high a water level or sudden excessive steam demand exists, the correction of such evils does not lie within the power of even the most adequate water treatment. Anti-foam action will pay dividends in the form of delivery of a purer steam and general minimization of maintenance costs chargeable to equipment through which the purer steam flows.

Development of an All-Colloidal Treatment

In the desire to create a successful all-colloidal organic method of water conditioning, the use of which would yield the results expected from adequate water treatment without the shortcomings previously described, extensive research in that direction had been commenced many years ago. After more than 20 years of research with many years of subsequent experimentation under actual operating conditions, a product was developed which is a combination of a number of organic substances properly processed to a colloidal state. The product was produced in the form of a liquid organic-colloidal emulsion which comes ready for use, simplifying its introduction to equipment. Actual application is taking place in locomotive, marine and stationary steam generating equipment, in many parts of the world with waters of variable composition and under manifold operating conditions. A case history of interest to power plant stationary boiler operators is use of this method in the power plant of the United States Military Academy at West Point, New York, over the past five years.

Equipment at West Point

The boilers produce approximately 3,000,000 lb of steam daily supplying turbines for the generation of power, and the various heating, laundry, valet and cooking requirements. The needs of the Post resemble that of a moderate sized community served by a small central station. The original turbine plant consisted of three turbo-generators each of 1000 kw. In October of 1945 a 1500 kw condensing type turbo-generator was installed as the result of a modernization plan. The boiler plant itself consists of three water-wall Badenhausen four drum boilers of special design. Two of the units are rated at 120,000 lb of steam per hour and one at 180,000 lb per hour. All three units are in use except in the summertime when the load is such that only two of the units are usually on the line. All boilers are operated at 160 psi pressure. In line with existing requirements, at the end of last year these boilers which originally burned coal were all converted to oil. In place of underfeed stokers, latest type oil burners were installed; total burner capacity of the plant is 40,000 gal oil per day. Another recent change in the boiler plant included the installation of superheaters to raise the steam temperature an additional 50 F. Three tanks each capable of storing 17,500 bbl of oil were installed to insure an adequate oil supply.

Feedwater Treatment History

The raw water make-up which is in the neighborhood of 40 per cent is fed to the return condensate tank, then pumped through a closed type feedwater heater reaching a temperature of 220 F. In the economizer the final temperature is brought to around 270 F.

In Table 1 is shown an analysis of the raw water in use which is drawn from a lake. After filtration the water is chlorinated and its pH adjusted slightly, chiefly for drinking purposes, by the addition of lime prior to being delivered to the boiler plant.

Table I. Representative Analysis of Raw Water Delivered to Boiler Plant

pH	8.6	
Chlorides	7	ppm
Hardness	27.8	ppm
Phenolphthalein Alkalinity	25	ppm
Methyl Orange Alkalinity	37.5	ppm
Sulphates	71.0	ppm
Dissolved Oxygen	9.0	ppm
Iron	.03	ppm
Silica	Present	

It was found in practice that prior to the use of all-colloidal organic conditioning, trouble was experienced in scaling of the tubes and drums, despite the application of various inorganic chemical treatments and although all recommended analytical control was strictly adhered to. Not only was there deposition of scale,

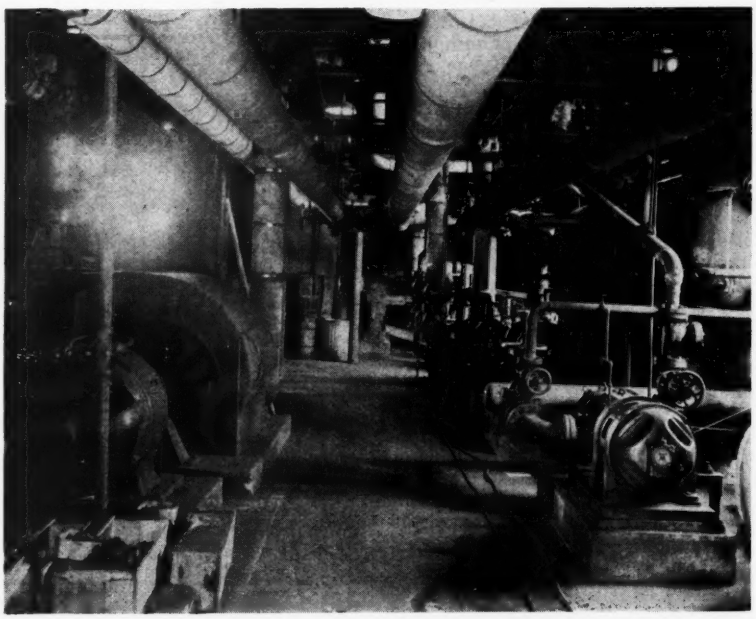
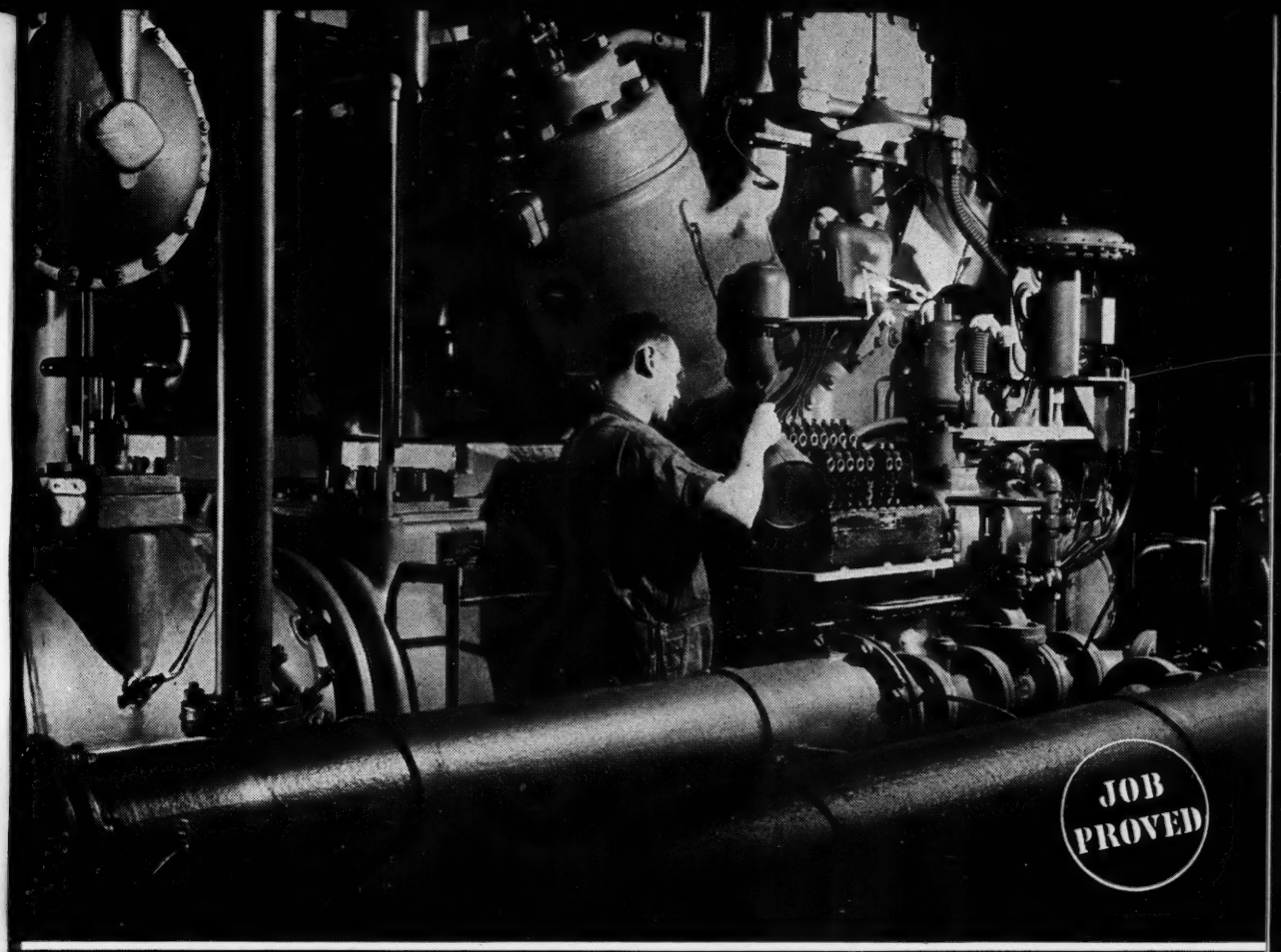


Fig. 5. Feedwater lines, feedwater pumps and return condensate tank. (Photo U. S. Army, Corps of Engineers)



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For three years these 2-cycle 400-H.P. Diesel compressors ran almost continuously. Night and day . . . week after week . . . they piled up over 20,000 hours of operation.

Lubrication problems didn't exist for these engines, according to engineers. A "Job-Proved" Sun oil, specially developed for Diesels, was used from the very first day. When the engines were finally disassembled there were no stuck rings, no hard carbon or gummy deposits.

No wear was apparent. No replacement of parts was necessary.

Sun Diesel lubricants are low in carbon. They withstand extreme pressures and temperatures. They stand up on heavy-duty jobs. Call the Sun man near you for full information on the petroleum products that are "Job-Proved."

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". . . corrosion control is provided in two-fold fashion, by film formation and adsorption."

particularly in the 2½ in. tubes but also some foaming occurred. Inspection of the turbines showed hard deposits on the blades which were difficult to clean.

Treatment with the All-Colloidal Emulsion

At the same time that these difficulties were being experienced in the main power plant, a test was conducted for over a year in supplementary boilers located in the post hotel and laundry with the all-colloidal organic method. Results of this test were so satisfactory that, in view of the difficulties being experienced in the main power plant, it was decided to extend this method as treatment to the boilers of the main power plant. This was in 1941.

This treatment, being a liquid emulsion and requiring no preparation by the plant personnel, was introduced directly into the return tank as the simplest procedure possible. An enlarged chamber made of readily available piping was used as a reservoir to feed the treatment to the return tank in the form of a drip gravity feed. Treatment in proportion to the makeup water drawn by each of the boilers was thus assured.

With the introduction of the all-colloidal organic emulsion, it was possible to discontinue many boiler water tests, such as those for pH, hardness, phosphates, etc. The only basic testing required was an occasional check of the raw water makeup for hardness only. The application of this treatment is based on a thorough original survey of the plant, operating conditions and water supply data, resulting in the rendering of a specification. The only control required in addition to the raw water test is a periodic check-up on operating data, especially pertaining to such factors as steam production and makeup.

From the time the treatment was changed, no difficulty whatsoever was experienced in handling or introduction. An item of particular interest to every boiler operator, whether or not he has also to consider superheaters and auxiliary equipment such as steam engines or turbines, is the fact that this paritcular emulsion is recommended by leading manufacturers of distilled water stills for the prevention of scale, corrosion and foaming. At West Point, benefits of this nature were readily observable in inspections made of equipment.

As regards blowdown, it had been the practice to supplement the continuous blowdown manually. With the use of the all-colloidal emulsion, it was possible to discontinue the continuous blowdown. The schedule now consists of manual blowdown once per watch. The units are blown down from each side and from the rear. This possibility of eliminating continuous blowdown was due to the more efficient removal of suspended matter achieved with this treatment as compared to the use of inorganic chemicals.

Boiler Condition

Prior to 1941 the average rate of tube replacement due to waterside conditions was two to three tubes per year per boiler. Since the introduction of the all-colloidal organic emulsion there have been no tube replacements required due to lack of proper water conditioning.

Now after five years of operation, all the old troubles previously experienced no longer exist and the boilers are merely opened and washed on a yearly schedule. A thin film is present in the drums and tubes on draining and merely a hosing with water is required.

"Anti-foam action will pay dividends in the form of delivery of a purer steam and general minimization of maintenance costs. . ."

This illustration of the successful adoption of the all-colloidal organic water conditioner shows the substantial benefits possible as the result of the utilization of purely physical properties. In addition to simplicity of application and the elimination of a great number of analytical tests normally required, maintenance and repairs chargeable to lack of proper water treatment, whether in the boiler itself, in lines, or in equipment such as superheaters and turbines, are minimized. Additional savings can be realized due to the possible reduction in the amount of blowdown required, easier and less frequent washings and increased equipment availability.

RESINS IN COAL

THE RELEASE OF a new Bureau of Mines publication summarizing available knowledge on the nature, occurrence, and possible commercial utilization of resins found in coal, particularly the coals of the United States and Canada, was recently announced.

Prepared by W. S. Selvig, a supervising chemist at the Bureau's Central Experiment station at Pittsburgh, Pa., the publication quotes the results of research indicating that these resins might be used for certain grades of varnish if they were obtainable commercially at low prices.

Two forms of resins are visible in coal. One form present in most coals is visible only under a microscope and consists of tiny particles so closely mixed with the coal that they cannot be removed by mechanical means. The other form, a lump-type resin, is visible to the naked eye and can be recovered by crushing the coal and removing the separated resins by flotation methods.

Some western coals contain approximately 5 per cent of these lump-type resins, which may be the fossilized product of secretions from ancient trees. Many properties of these resins probably are similar to those of the natural resins of commerce, which are imported in large quantities and used in manufacturing varnish, lacquer, printing ink, and linoleum.

A copy of the publication, Technical Paper 680, "Resins in Coal," by W. A. Selvig, may be obtained for 10 cents by writing to the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

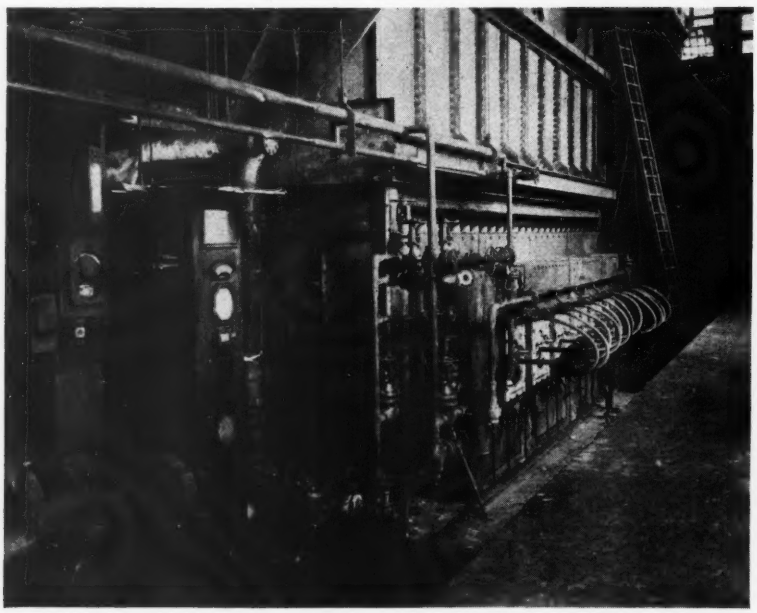

Fig. 6. Front view of boiler No. 3 showing fuel oil burner installation. (Photo, U. S. Army, Corps of Engineers)

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ATOMICS

Underwater Atomic Bomb Blows 1,000,000 Tons of Water a Mile High, Sinks 3 Big Ships a Mile Apart

By **ANDREW W. KRAMER** Managing Editor, Power Plant Engineering
Accredited Correspondent, Operation Crossroads

Aboard the U. S. S. Appalachian, July 22, 1946

TWO DAYS before Test Baker is scheduled, there is a great deal of speculation among the scientists, military, observers and newspaper men as to the effect of the underwater atomic bomb blast. There is much loose, ill advised comment among those without particular scientific training but even among the scientists there are differences in opinion. This, of course, is perfectly natural, since no atomic bomb has ever been detonated under water and even with the best of supporting data it is easily possible to arrive at various solutions.

Among the more spectacular predictions are those that point to a column of water, a half mile in diameter and from 8,000 to 10,000 feet high, representing a million tons of water. Some scientists estimate that this column will rise in solid form from 8000 to 10,000 feet but that geyser like spray may reach to a height of 20,000 feet.

In the various press conferences which the newspaper representatives have had with the scientific staff of Joint Task Force One, the newspaper men continually dwell on trivialities which have little significance in this great operation. What became of pig 311 which was found swimming in the water after Test Able, seems of far greater importance to the newspaper men than questions concerning the underwater test which are really significant.

Effect of Underwater Test on Efficiency

One factor, for example, that has received no attention whatever in all the discussions is what effect the underwater test will have on the efficiency of the nuclear reaction. All the previous atomic bombs have been detonated in air, which is easily compressible and therefore offers little resistance to the expansion of the fissionable material during the blast.

Now, it is well known that the efficiency of the reaction depends upon the length of time that the fissionable material can be held together once the reaction has started. In the atomic bomb itself, of course, the inertia of the casing and the tamper material resists the expansion to a limited extent, but the strength of

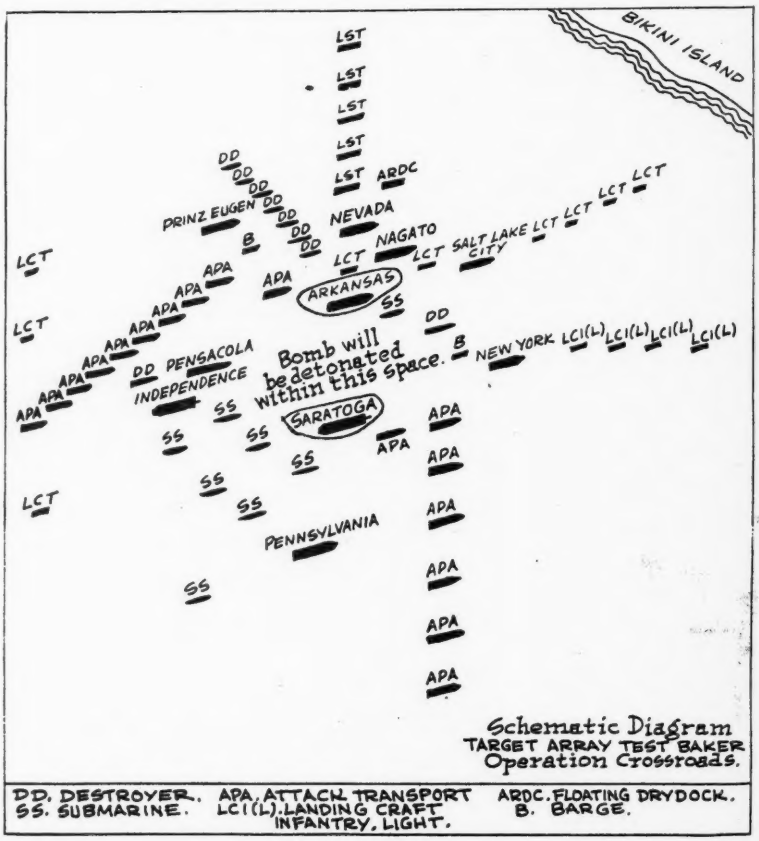

Fig. 1. Approximate disposition of ships in target array, second atomic bomb test at Bikini

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Together, these features of Edward non-return valve design increase boiler plant efficiency, cut operating costs, give maximum protection in an emergency. They are among the reasons Edward non-return valves are specified for a majority of the stations where service conditions are the most exacting.

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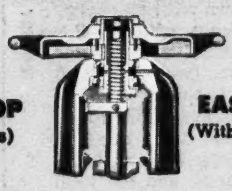

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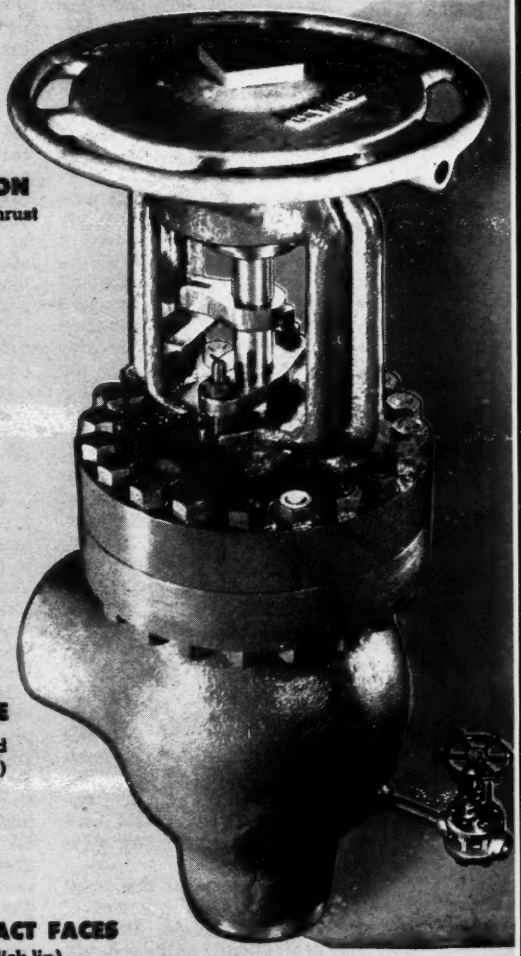
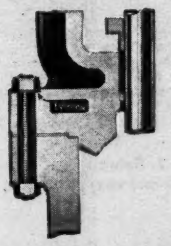


...Y DISASSEMBLY
...gh Edward EVinlay ...bearing surfaces)



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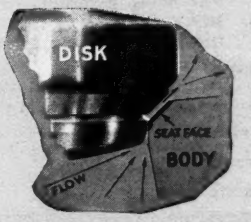

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E V E

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the casing however heavy is small in comparison to the force of the nuclear reaction, and in a short time the casing material is accelerated to a point where it no longer is a factor in keeping the fissionable material together. At that point, unless the nuclear reaction has proceeded to a degree where most of the fissionable material has been subjected to fission, the reaction would stop by virtue of the separation of the remaining fissionable material.

Number of Neutron Generations Important

No specific data is available in regard to the number of neutron generations which have to take place before a bomb can become effective but from certain fundamentals it is possible to speculate and even calculate the number of generations to produce fission in all of the nuclei in a volume of, say 50 kilograms of fissionable material. Without going through the calculations it can be said here that about 80 generations of neutrons would be necessary to completely fission a 50 kilogram mass containing 10^{26} nuclei. What this means is, that if in such a mass we produced fission in one nucleus, this fission would produce, say, two new neutrons. This would count as one generation. These two neutrons in turn would produce fission in two other nuclei resulting in the production of four new neutrons. This then would be the second generation. The four neutrons would in turn produce eight neutrons, and so on, until all the nuclei were fissioned. It is obvious that the reaction proceeds as a geometrical progression, and, so, despite the fact that the mass contains 10^{26} nuclei, only 80 generations would have to take place before the entire mass was used up.

Now, it is interesting at this point to note that after three quarters of the reaction is complete, that is, after 60 generations, only one-millionth of the total potential energy of the reaction will have been released and that during the **last six generations ninety-eight per cent of the energy is released.**

Reaction Time

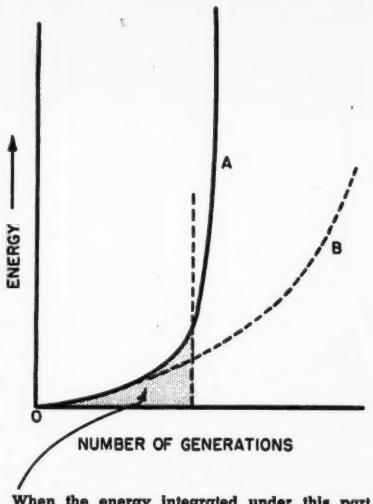
This shows how important it is to keep the mass intact as long as possible. Incidentally, the total time necessary for a chain reaction of eighty generations is very small and can be calculated with a fair degree of accuracy. Let us assume that all the neutrons are born with an energy of 2 Mev, or a velocity of about 2 x 10^9 cm per sec. Therefore the time between generations (which in such a fast fission chain is simply the time between single impacts of neutrons with nuclei, i.e., the time required to traverse one mean free path) is about 2 x 10^{-9} seconds, and the total reaction would require only 0.16 microseconds.

Of course, it must be understood that these considerations of reaction time are hypothetical because no account is taken of the geometry of the bomb.

In an actual bomb, the fissionable material is disposed in subcritical masses which are assembled in such a way that the reactivity of the system is a function of the geometry of the masses. This results in a reactivity which is a function of the time necessary to bring the separate masses together and as a consequence the figures we have calculated here can only be considered as the lower limit of the reaction time.

If our hypothetical bomb were divided into two parts and the 25-kg projectile shot into the remaining 25-kg mass as a target with a velocity of 2000 ft per sec, its total energy would be equal to 10^{-11} of the total energy of the nuclear reaction and from this it is evident that only about 26 generations of the reaction would be required to stop the projectile and the next generation alone would generate enough energy to repel it again.

It is therefore of great importance to design the bomb in such a way that the reactivity of the fissionable mass is a sharp exponential function of the position of the projectile from the target in the hope that during the small interval between the time after the projectile has been stopped and before the bomb has expanded appreciably, a very large fraction of the energy may be released. This is illustrated in the curves shown in Fig. 2.



When the energy integrated under this part of the curve equals the energy of the projectile, everything depends on what happens in the next fission generation. If the energy release takes the form of curve A, there is good chance of success; but not if it takes the form of curve B

Fig. 2. Relation between generation of neutrons and energy release in the atomic bomb

The desired effect can be achieved by varying at least three factors: 1. increasing the velocity of the projectile, 2. retarding the expansion of the reacting mass by surrounding it with a high inertia tamper and 3. reducing the initial number of neutrons in order that the reaction will not go on to an appreciable extent before the reactivity has approached its maximum value.

Fig. 3. Ships anchored in Bikini Lagoon before atomic bomb tests, including both Joint Task Force One and target ships

TERRY

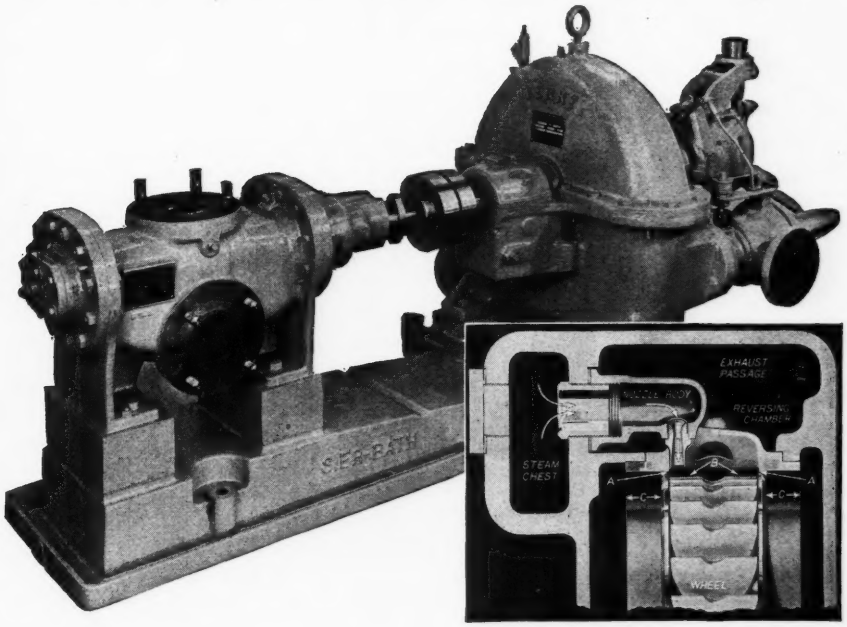


DIAGRAM SHOWING WHEEL CLEARANCES

AA — Rim clearance, B — Large blade clearance, CC — Side clearance, (about one inch). Blades cannot foul, as they are protected by rims. Rubbing at AA will do no damage. Side clearance is so large that end-play from excessive external thrust cannot damage wheel.

AMPLE WHEEL CLEARANCES IN THE TERRY WHEEL TURBINE INCREASE DEPENDABILITY

In the Terry Solid Wheel Turbine the buckets have large radial and axial clearance. They are further protected by projecting rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the radial clearance became reduced.

It is, therefore, impossible for the blades to foul. As the side clearance is very large (one inch), end play can do no damage.

Such construction makes for dependable operation.

The Terry Wheel Turbine is described in our Bulletin S-116. A request on your business letterhead will bring a copy.

Above: Typical Terry Wheel Turbine direct connected to Fuel Oil Pump. Unit is rated 24 H.P. at 1200 R.P.M.

T-1163

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

ATOMICS

The Second Bomb Blast Under Water

Aboard the U. S. S. Appalachian, July 25, 1946.

IMAGINE a solid column of water some 5000 ft high with a boiling, surging mass of gas and vapor rising to a height of 9000 ft; the whole mass a half mile in diameter at its base but considerably wider at the top; imagine the energy that it would take to send such a column into the air.

Difficult as it is to imagine this, this is what actually happened at Bikini in the second atomic bomb test on July 25. And, still more difficult to imagine is the fact that this enormous force, this greatest underwater explosion the world has ever seen, was brought about by the conversion of a small amount of plutonium scarcely as large as a dime!

Don't misunderstand this statement; it does not mean that the amount of plutonium in the bomb was no bigger than a dime; the total mass was considerably larger, but, of that total amount, probably a mass of about one gram was converted into energy. According to the Einstein mass-energy equivalence equation, $E = mc^2$, the energy resulting from the conversion of one gram of matter into energy is the equivalent of that which would be produced by the explosion of 20,000 tons of TNT.

Even with an understanding of the physics of the reaction it is still almost beyond the power of the mind to realize the enormity of the force that results from the disappearance of so tiny a bit of matter. One has to witness the blast and then one still wonders about it. Most of us who were fortunate to be able to witness this test were astonished beyond all our expectations by its grandeur. It was one of the most magnificent spectacles man has ever produced. It exceeded, by far, the aerial burst on July 1, even taking into account that at this test we were eight miles closer to the blast. At the time of detonation, we were just ten miles from the target array in which the bomb was placed.

How the Bomb Was Placed

As is well known by this time, this bomb was detonated under water. The exact depth is a matter of military security but since the average depth of Bikini Lagoon is only about 25 fathoms (150 ft) it can be assumed that the depth was somewhere between 100 and 125 ft. It is reasonable to assume that the bomb would be placed as deep as possible but not resting on the floor of the lagoon.

The bomb was suspended from a LSM (Landing Ship Medium) a small type of craft used for transporting medium tanks. This vessel, 203 ft long, 34 ft wide was chosen for this task because of her stability and construction.

As in the case of the aerial bomb used in the "Able Day" test on July 1, many of the dire predictions regarding the destructive power of the under-water blast did not materialize, particularly those in regard to the number of ships that would be destroyed. Some prophets had predicted that ships would be thrown high into the air, that others would be capsized by the huge tidal waves that would be created, etc.

Evaluation of Damage

None of these things happened. At the time of this writing, late in the afternoon of the day of the blast, it is too early to accurately evaluate the damage since no damage inspection parties have been able to enter the target area. It is evident, however, that nearly all of the ships are still afloat. Two have been sunk, however; the old battleship Arkansas and the large aircraft carrier Saratoga. The Arkansas went down almost immediately after the blast and the Saratoga lingered in a sinking condition until late this afternoon. She finally disappeared beneath the waters of Bikini Lagoon a few minutes after four o'clock, seven and a half hours after the blast. (The Nagato sank 4 days after the blast.)

Because of the absence of wholesale destruction of ships, there may be a tendency on the part of some, particularly those who did not witness these tests, to minimize the importance of the atomic bomb as an instrument of destruction and it is partly the purpose of this report to dispel all such notions. No person who witnessed the blast, no one who saw a million or more tons of water lifted a mile high, who saw the great cloud of vapor, spray and gas spread out over the surface of the water a distance of three or four miles in a few seconds can minimize the importance of the atomic bomb. Obviously, most of the destructive energy of the nuclear reaction was expended in lifting the water against the force of gravity, in vaporizing it, and in creating the huge waves that swept over the lagoon.

Aside from the immediately visible effects, however, consider the destruction of the two capital ships. Reference to the chart showing the disposition of the ships in the target array will show that the Arkansas and the Saratoga were anchored adjacent to the area in which the bomb was detonated. Since there is no scale of distance shown on the chart, it is not apparent but these two ships actually were almost a mile apart. It is not known, of course, where in the area between the two ships the bomb was placed but if we assume that it was placed midway between them, it will have been some 2000 ft from either ship. And, both of these great ships were sunk! This gives some idea of the enormous power of the blast.

During the war, in aerial bombing operations, if a bomb fell within a few yards of a target vessel it was classified as a "near miss." Such

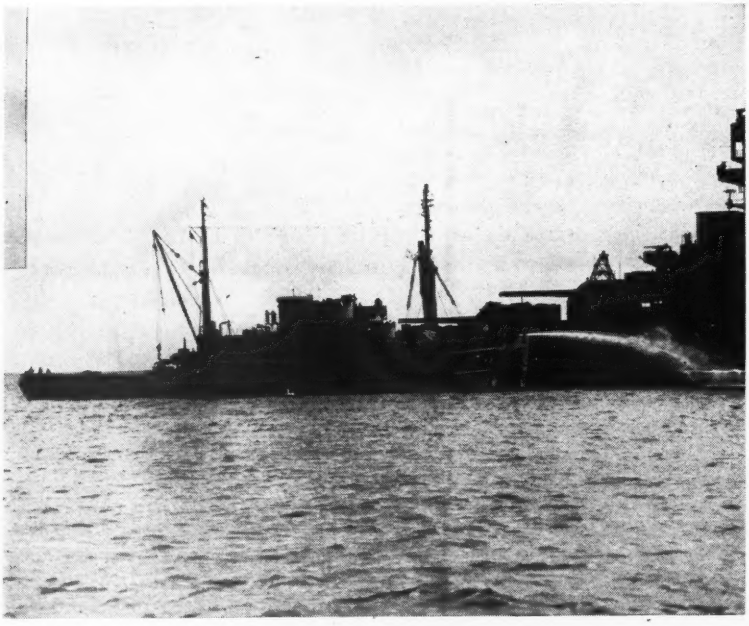


Fig. 4. Tug washing down sides of U.S.S. Pennsylvania before inspection party boards her following Test Able on July 1

All photos courtesy Joint Army-Navy Task Force One.

WICKES 4-DRUM BOILERS

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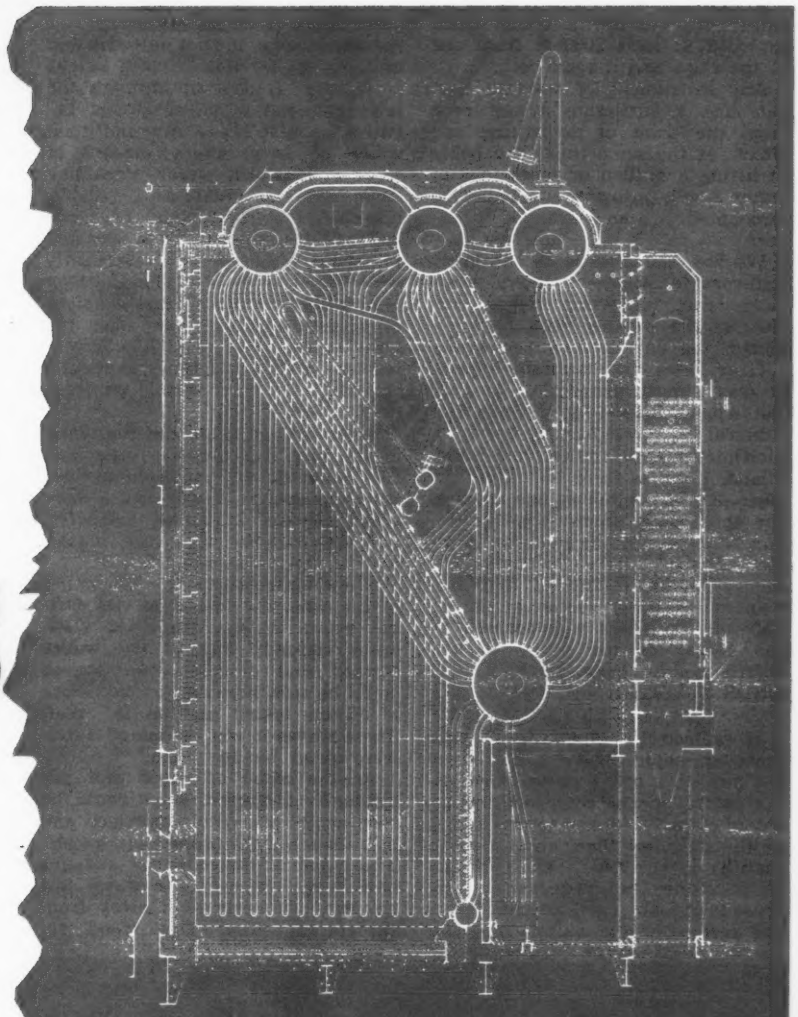

The unsurpassed dependability of Wickes 4-Drum Boilers is the result of careful workmanship applied to time-tested boiler design. As shown in the diagram, the three upper drums are installed nearly on a line and are connected by multiple circulating tubes to assure constant water levels at all ratings. Other readily apparent advantages are large diameter drums, minimum number of tube bends, and steam liberating area sufficiently large to insure rapid response to load changes. Tube arrangement and number may be modified to suit various stoker widths and other firing methods. Wickes 4-Drum Boilers are built for pressures up to 1,000 lbs. per hr., and capacities to 250,000 lbs. steam per hr. Our engineers will be glad to study your boiler requirements and show you how these or other Wickes boilers will increase power efficiency in your plant.

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near misses were rarely fatal to ships but here was a bomb which exploded at least 2000 ft from one of the ships and it sank both.

Any instrument of warfare that can sink a battleship a half mile from the point of detonation and which, at the same time, is capable of lifting a million or more tons of water a mile into the air cannot be discounted on any grounds whatever.

We had had a week of extremely unfavorable weather; heavy overcasts, rain, uncertain winds, etc. But, as the weather boys had predicted, the day dawned beautifully —clear skies and favorable winds. It was almost incredible. At 8:30 the Appalachian in company with Admiral Blandy's flagship, the Mt. McKinley was 8½ miles from Bikini Island, 10 miles from the target array. At H-hour minus five minutes the ship's loud speaker system began to announce the minutes. Four minutes to go, three minutes, two, then ONE MINUTE. At that moment the suspense was great. Every pair of binoculars was focused on the center of the array—it was clearly visible. Then, THIRTY SECONDS TO GO!

The Underwater Explosion

It seemed less than 30 seconds, however, before there appeared on the horizon a great white bulge rising swiftly in the center of the array of ships. It seemed to rise slowly at the start but then, almost immediately, it burst into an enormous mass rising swiftly higher and spreading out horizontally across the surface of the water. In a few seconds it enveloped all but the outermost vessels in the array. At the same time it shot upward and in about 20 sec it reached a height of a mile. It shot up through the few scattered cumulus clouds between us and the array and then could be seen, great masses of slightly brownish water streaming down over a great area. Above, however, the great cloud of vapor and gas continued to surge upward, billowing outward in a brilliantly white cumulus type of cloud.

In 44 sec it had reached a height of 6700 ft and 2½ min after the blast it was 8400 ft high where it leveled off. By this time practically the entire array of vessels was covered.

About 50 sec after the beginning of the blast the pressure wave and the sound of the explosion arrived simultaneously. It was not a loud noise, more of a muffled character, but the pressure was very noticeable on the ear drums.

A few minutes after the beginning of the blast the few ships still visible could be seen to rock, some quite violently due to the waves formed and shortly after waves could be seen breaking on the shore of Bikini Island and on the reef. These waves it was estimated, later, were about ten feet high.

As the cloud of vapor and gas gradually dispersed, ships could be seen again, not visibly damaged and by 9:20 all of the ships were visible. The cloud of mixed vapor and gas still hung low over the water but the wind had carried it away from the target area. This cloud remained visible as a light brown haze for about three hours, the wind gradually carrying it farther and farther away. At 10 o'clock the Saratoga could be seen listing to port and as the day wore on this list steadily increased, until she sank shortly after four o'clock.

The bomb is said to have been similar to the one used in the Able Day test and it is unlikely that its nuclear efficiency was higher because it was immersed in the water. At first it appeared that surrounding the bomb by a high inertia medium such as water might increase the efficiency of reaction but it now appears that the water could have had little effect. The chain reaction in the plutonium was completed in a fraction of a millionth of a second and until that time the bomb did not know what kind of material surrounded it.

Aside from the damage to ships, the radioactivity must be considered. At the present writing, some ten hours after the blast no person can enter the area where the explosion occurred. The radioactivity is so intense that exposure even for a short time would be deadly. It follows, therefore, that if there had been personnel aboard these ships, even if they had survived the shock of the blast, they would have been subjected to the radiation effects, undoubtedly with fatal consequences.

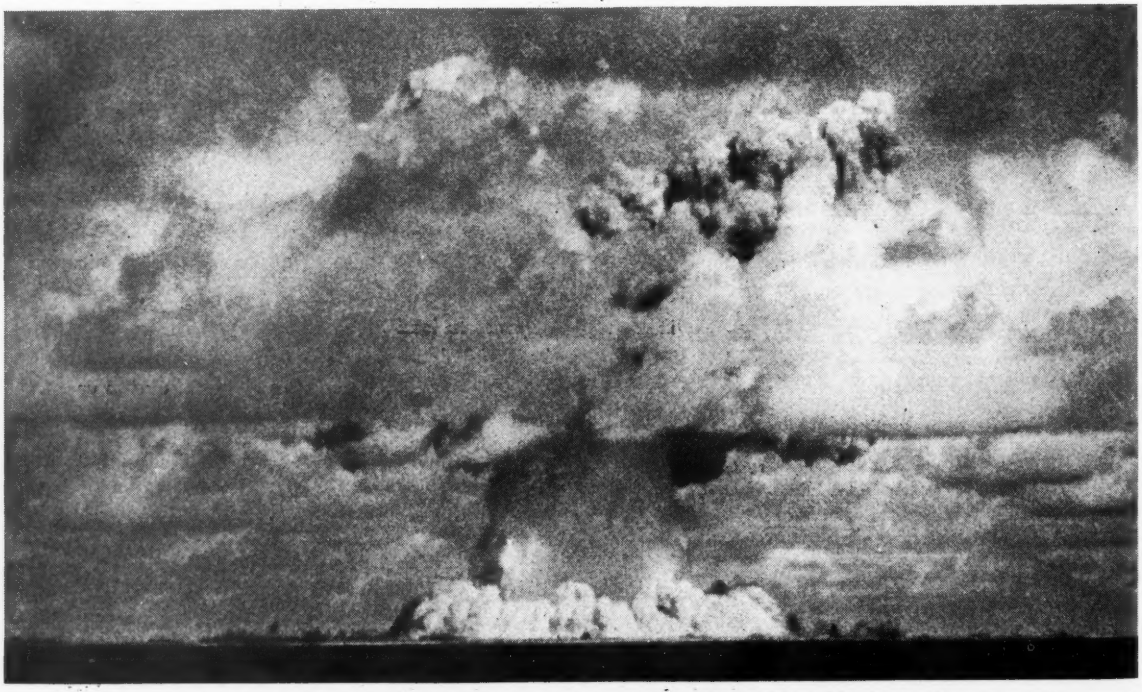
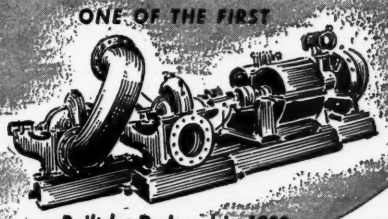


Fig. 5. Enlargement of a 35-mm motion picture film, taken by an automatic camera on Bikini Island, showing water column and cloud produced by underwater atomic bomb blast

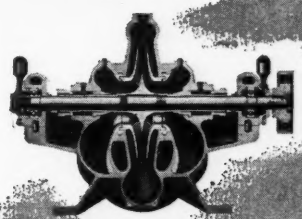
45 Years of PUMP IMPROVEMENT

ONE OF THE FIRST

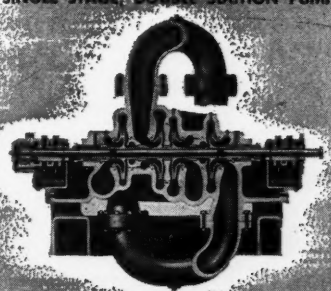


Built by De Laval in 1902

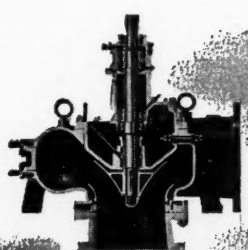
Modern De Laval centrifugal pumps represent the culmination of more than 45 years of continual improvement and perfection. This long period of concentration upon the problems of centrifugal pump design and application places at the user's command a complete line of modern, high quality pumps and a vast store of knowledge concerning pump application problems.



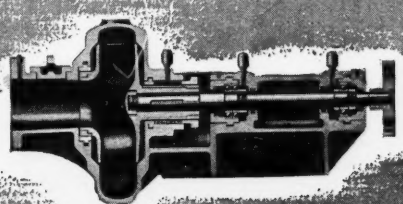
SINGLE STAGE, DOUBLE SUCTION PUMP



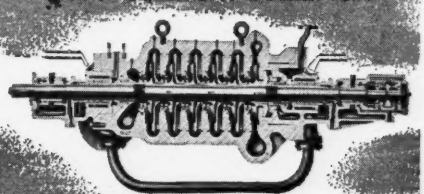
FOUR STAGE, OPPOSED IMPELLER PUMP



MIXED FLOW PUMP



CLOGLESS PUMP



HIGH PRESSURE, MULTI-STAGE PUMP

GP-1

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Plant Cuts Power Consumption 38 Per Cent

FIFTY-EIGHT per cent reduction in kilowatt-hours used for lighting and thirty-eight per cent reduction in overall power consumption while production was held at 5/6 of normal is the remarkable record shown by one Chicago manufacturer in the recent dimout caused by the coal strike, proving that power can be saved when conditions demand drastic action. If similar savings could be made generally throughout the country in times when no critical fuel shortage exists considerable of the burden on our fuel industries and transportation systems would be lifted.

Although classified as an essential industry and permitted to operate on a five-day week, the plant nonetheless endeavored in every way possible to reduce its power consumption, and during the second week of curtailment achieved a thirty-eight and two-tenths per cent reduction in total kilowatt-hours, which was only one and eight tenths per cent below the public utility company's goal of forty per cent savings.

Plant officials credit the major portion of the reduction to the vigilance of monitors appointed in each department to see that the use of electricity was held to an absolute minimum, although certain other deviations from normal operating procedure were employed to help save power.

Previous to curtailment, the plant operated on a 24 hr day, 6 day week, employing three shifts. The third shift was considerably smaller than the other two, and the janitors normally cleaned the building during this time, using many lights in departments where nobody was working.

In order to effect the substantial saving, the third shift was eliminated and the personnel from it worked at the same time as the second shift, and the jantiors worked from 4 p. m. to midnight instead from 10 p. m. to 6 a. m. as before. Footcandles of illumination were reduced in many parts of the plant, and the office force used lights only 24 hr a week.

Kilowatt-hours used for lighting and power during the week preceding curtailment and the two weeks of curtailment and per cent savings realized are shown in the following tabulation:

Period*	Apr. 22 to 29	Apr. 29 to May 6	May 6 to 13
Lighting			
kwh/wk	31,440	22,960	13,240
% Saving	0	27	58
Power			
kwh/wk	37,240	32,480	29,240
% Saving	0	12.8	21.5
Total			
kwh/wk	68,680	55,440	42,480
% Saving	0	19.3	38.2

*Curtailment began May 2

Oil Maintenance

(Continued from page 79)

characteristics. Some of the most pronounced corrosive points in our oiling systems are those above the oil level with which the oil does not come in contact. Regardless of the effectiveness of a rust inhibitor, it cannot be expected to prevent corrosion at points in the system not in contact with the oil. The primary function of a lubricating oil is to lubricate the bearings or moving parts of a machine rather than to prevent corrosion in the oiling system. Perhaps the logical approach to the corrosion problem in our oiling systems would be to fabricate the system from non-ferrous metals having the least catalytic action on the oil rather than to place the undue burden of corrosion prevention on the lubricating oil itself.

At present, the nature of most rust inhibitors in turbine oils is such that refiners contend they cannot be properly purified in service by fuller's earth, the most effective purifying medium known. Due to the close tolerances and high rubbing speeds of turbine bearings, abrasives of any nature or water in appreciable percentages cannot be tolerated; and this fact may be the "stumbling block" in the ultimate success of rust inhibitors combined with the oil. Corrosion in the oiling systems of turbines is the exception rather than the rule, and the seriousness of the whole problem may have become somewhat exaggerated during the past few years.

Products of oxidation of petroleum lubricants may be divided into two general classes with reference to molecular weight. The low molecular weight or high volatile products of oxidation are highly corrosive to metals as they vaporize and combine with water vapors on the surface of the metal of the oiling system above the level of the oil. The high molecular weight or low volatile products of oxidation are, in themselves, good rust preventives. In service, the high molecular weight products of oxidation eventually protect the surfaces of metal of the oiling systems of turbines with which they come in contact.

Corrosion in turbines that have been in service for a few years is seldom encountered. Perhaps a reasonable solution to the corrosion problem in new installations would be to start them up with an oil containing a rust inhibitor of the plating type; operate for several weeks or until such time as the inhibitor has plated the surface of the metal with which it comes in contact; then purify the oil through fuller's earth to remove all traces of the rust inhibitor remaining in the oil, restoring its water-separating properties to an S. E. value of fifty or less for insured operating safety.

When make-up oil containing rust inhibitor is added, say once a year, do not use a purifier for a few weeks until the plating type rust inhibitor has had an opportunity to cover any surface of metal from which the rust inhibitor may have been removed by erosion, etc. Then proceed with the purification when and as necessary to maintain S. E. number and neutralization number to the desired level. Close cooperation by all concerned with the corrosion problem of oiling systems of turbines is necessary to eventually arrive at the most satisfactory solution.

Hydro-Electric Turbines

Lubricating oils for hydro-electric turbines are usually the same as are employed for steam turbines. Oil temperatures, however, are usually somewhat lower than oil temperatures of steam turbines; hence, the rate of decomposition of the oil is less, with resultant longer life. The maintenance and purification of hydro-electric lubricating oils is identical with that of the steam turbine or other industrial equipment. Contaminants are equally as objectionable and should be held within limits to insure the maximum of operating safety and over-all efficiency.

Reciprocating Steam Engines

The reciprocating steam engine presents two different lubricating problems:

1. Internal lubrication, cylinders and valves.

2. External lubrication, bearings, crosshead, valve actuating mechanisms, etc.

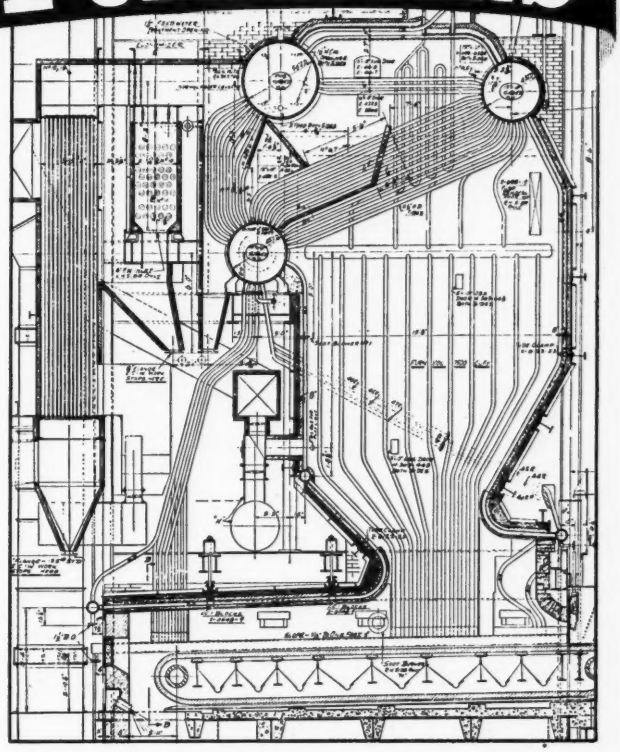
Cylinder oils are used but once, and their maintenance is not a problem. Steam cylinder oils are usually compounded with from three to ten percent of fatty oils, such as acidless tallow, prime lard, degras, or a combination of one or more, and range in viscosity from 100 to 300 S. U. V. at 210 F. The selection of the proper viscosity and percentage of compound for a given operation is usually based on steam pressures and temperatures.

In general, steam cylinder oils are applied in the steam line one foot to six feet ahead of the valve or steam chest. Various types of atomizers are generally provided to break up the cylinder oil and thoroughly mix it with the steam. Just how or why this practice originated is not clear in the literature but is generally regarded as the best method of applying cylinder oils. Where cylinder oils are properly atomized and mixed with the steam, only a minor percentage of the oil, at best, reaches the points to be lubricated.

Much better and more economical lubrication would result if the cylinder oil was applied directly to the cylinder at one or more points in the horizontal engine, depending upon the bore of the cylinder, and at two or more points in the vertical engine, depending upon the cylinder bore. With this application, the highest viscosity cylinder oil could be used, regardless of steam pressures or temperatures. This fact has been conclusively proven

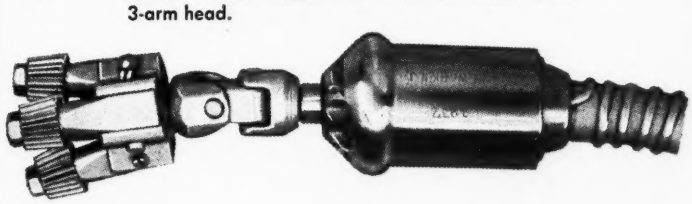
ROTO TUBE CLEANERS

for ERIE CITY *3-drum* BOILERS



Because clean tubes are so vital to efficient boiler operation, it is a real tribute to Roto Tube Cleaners that so many leading boiler manufacturers furnish them as standard equipment. Roto has specialized in tube cleaners since 1910, and is familiar with the specific requirements of practically all types of tubular equipment.

Illustrated here are an Erie City 3-Drum Boiler which generates 150,000 lbs steam per hr, and two types of Roto Tube Cleaners, either of which will clean all the tubes in this unit. Send for the Roto Tube Cleaner manual and catalog which contains valuable engineering data and illustrates the complete Roto line.



Above — Roto Model 22 water-driven motor with 3-arm head for operation where air is not available. *Below* — Roto Model 120 air-driven motor with 3-arm head.

Roto lubricator and 50-ft length of special left hand wire-wound Roto tube cleaner hose.

ROTO Division of ELLIOTT COMPANY
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in many reciprocating steam engines, particularly those having a large cylinder bore.

For the external lubrication of reciprocating steam engines, application is usually made by hand oiling, drip cups, splash, or circulating system, depending upon the design of the engine. The design of the reciprocating steam engine, in general, does not permit complete oil enclosure as does the steam turbine with the result that the lubricating oil is subjected to contamination by foreign materials to a greater degree.

Again, contaminants in external lubricants are our worst saboteurs, constantly taking their toll by increasing wear on the moving parts. In most instances, so-called "engine oils" (lubricating oils less highly refined) are employed. However, with the enclosed crankcase type or in accordance with the preference of the operator, lubricating oils of the turbine quality are widely used.

Adequate and effective oil purification systems are just as essential in removing contaminants as they occur in the lubricating oil for reciprocating steam engines as they are for the steam turbine. The selection of the purification system depends upon the nature and amount of contaminants to be removed.

Internal Combustion Engine

Lubrication of the internal combustion engine presents a far more difficult or critical problem than found in any other type of prime mover. In general, oil temperatures are considerably higher, which accelerates oxidation and serves to shorten its useful life. In addition, the oil on the surface of the metal within the combustion zone is subjected to temperatures far in excess of its burning or cracking points, with a resultant high rate of decomposition. A percentage of the oil from the cylinder walls which has been subjected to the heat of combustion is constantly being returned to the crankcase or oiling system together with varying percentages of the unburned and obviously highly oxidized fuel. The percentage of such objectionable contaminants finding their way into the crankcase or oiling system varies with:

1. The incompleteness of combustion.
2. Excess wear of the cylinder walls, pistons, piston rings, etc.
3. Worn valves.
4. Incorrect fuel.
5. Improper atomization of the fuel.
6. Incorrect grade of fuel.
7. Improper temperatures.
8. Variable speeds or loads.
9. Intermittent operation and excess idling.

It can be seen, therefore, that lubricating oils for the internal combustion engine, especially the trunk piston type engines, are subjected to contamination by products of oxidation of the lubricating oil and the unburned fuel to a degree not encountered in the lubrication of other prime movers. In addition to contamination by products of oxidation of the lubricating oil and fuel, the lubricating oil is subjected to contamination of foreign materials such as solids or abrasives taken into the engine with the intake air.

In the process of combustion of fuels, either gas, gasoline, or Diesel fuels, one gallon of water is created for each gallon of liquid fuel or the equivalent of gas, which must escape through the exhaust or into the crankcase, depending upon the mechanical condition of the particular engine. Water, when mixed with the oil in the system, forms low temperature sludges, more prominent during winter months when condensation of the water vapors is more pronounced.

High temperature sludges (products of oxidation) are also created by the unburned fuel and the lubricating oil subjected to the heat of combustion, apparent as gums, lacquers, etc., combined with varying percentages of free carbon, which are largely responsible for so-called "carbonaceous deposits" behind piston rings, cylinder heads, valves, etc. Obviously, varying percentages of the high temperature sludges find their way into the crankcase oil, which serves to further shorten its useful life and impair its lubricating properties.

When these facts are fully appreciated, the useful life of the lubricating oil in the internal combustion engine, as compared to the useful life of lubricants of other prime movers or machines, becomes readily apparent. Lubricating oils, contrary to the belief of many, do not "wear out" but are rendered unsuitable for continued use by contamination from foreign materials or products of oxidation of the oil and/or fuel itself. Maintenance of the lubricating oils of the internal combustion engine through the use of adequate purification equipment which will remove contaminants of any nature as rapidly as they find their way into the lubricating oil is the medium by which the maximum of lubricating efficiency may be expected.

As stated, the rate of contamination of the lubricating oil in a given engine varies with the mechanical condition of the engine, completeness of combustion of the fuel, and the severity of service. An effective purifier therefor, depends on its ability to remove all contaminants as they are created. If this is accomplished, the life of the filtering medium employed in the purifier must vary with the load placed upon it. This explains the variable life of the filtering media from one engine to another.

To improve the operating difficulties resulting from the accumulation of objectionable deposits in the internal combustion engine, "detergent" type oils, more generally known as "H. D." oils or "Heavy Duty" oils have been perfected by refiners during the past few years. The primary function of the detergent type oils is to retain in suspension in the oil all solids, free carbon, or products of oxidation, preventing their precipitation and subsequent forming of objectionable deposits. The amount of detergent that can be added to a given oil is within certain limits.

A detergent is not an indispensable material, and its effectiveness depends upon the amount of contaminants which it can retain in suspension. Hence, the life of a detergent oil may vary with the amount of contaminants in, or created in, the oil within a given period of time or until such time that a definite percentage of contaminants have spent or used up the detergent. Preferably before this period has been reached, the oil should be drained and the system replenished with new oil.

Detergent oils have proven valuable and effective, particularly in the smaller size engines where the volume of oil in the system is sufficiently small to permit of more frequent crankcase changes within economical operating costs. The rate of contamination by products of oxidation in the small, high-speed internal combustion engine is considerably higher than that in the slow-speed, larger size engines.

The volume of oil in the system of the larger size, slow-speed engine limits the frequency of oil changes with an economical operating cost. Detergent type oils, due to the manner in which the detergent functions, are obviously not purifiable oils in the true sense of purification. Like all valuable contributions to the science of lubrication, detergent type oils are too generally regarded as a "cure-all" for all lubricating problems encountered in the internal combustion engine, regardless of its size or service.

Use and ultimate suitability of the detergent type oil in the large, slow-speed internal combustion engine where the volume of oil in the system will not permit more frequent changes, is as yet a highly controversial subject which, perhaps, time alone can solve. Many refiners, engineers, and operators recommend the use of the strainer type filter in connection with detergent oils for the larger size engines. The strainer type filter is, obviously, helpful and will remove certain percentages of the heavier sludges and the larger size abrasives, but will not remove the smaller size abrasives or the oil-soluble products of oxidation, which can eventually form objectionable deposits and create excess wear on the moving parts of the engine. The adequate maintenance of the lubricating oil, particularly in the larger size engines, by the use of an adequate purifier which will remove all contaminants as they are created or find their way into the oiling system may prove the answer to improved lubrication with a minimum of maintenance costs and operating difficulties.

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How Valves Are Used in TVA Hydroelectric Plants

By **H. J. PETERSEN** Head Mechanical Engr., Tennessee Valley Authority

THE FUNCTION of a valve in a piping system is either to regulate the flow of the fluid in the line or to sectionalize a piece of equipment or part of the system. Globe valves are used for the first function and gate valves for the second. Since most of the valves in hydro plants require only infrequent operation and are seldom used for throttling service, gate valves are used in the majority of cases. Globe valves are used on by-passes around special valves and regulators with a gate valve on either side of the equipment by-passed.

The Authority prefers a rising-stem valve to a nonrising-stem valve because the position of the stem indicates the position of the disk and because the stem threads are not in contact with the fluid. The O. S. & Y. type of rising-stem valve has the further advantage that the stem threads are outside the valve when open, making it possible to examine and lubricate them with the valve in service.

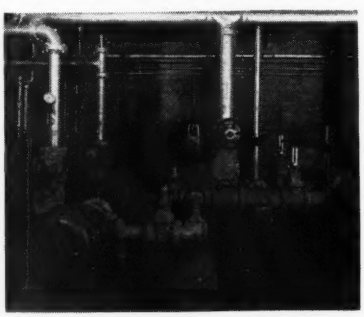
Globe valves usually are purchased with plug-type disks because that type of disk gives excellent throttling service, has great resistance to wear, and is easily repaired. The so-called composition disk has not proved as satisfactory for throttling and wears out quickly. Gate valves 2 in. and larger usually are purchased with double disks, and smaller than 2 in. with wedge disks. A double-disk valve gives a tighter shutoff and is more easily repaired in the field. Sometimes a larger size wedge-disk valve is used when it is impossible to install the valve with the stem up. In this position the disk of the double-disk valve is liable to jam. Gate valves smaller than 2 in. are purchased with wedge disks because, in our opinion, the various parts in a double-disk valve in those sizes are too small.

Valves 2 in. and smaller, both gate and globe, usually are purchased all brass because the extra cost involved is nominal. Larger valves are purchased iron body, bronze-mounted. The use of cleanouts in valve bodies has not been found necessary, nor has it been necessary to specify air-tested valves. Pressures encountered in hydroelectric plants seldom call for by-passes around valves, although at times it has been necessary to provide gearing for the larger size valves. This, of course, is a function of the pressure on the valve and is investigated for each condition. Larger valves which require fast operation, or are remotely controlled, are fitted with motor operators.

Check valves are used on the discharge of pumps and at all other places where it is imperative to prevent backflow of the fluid. Swing-check valves are preferred, but in some cases lift-check valves are used, especially for upward flow. A balanced-disk or spring-loaded check valve is used to prevent slamming and excessive surges in the higher head lines.

Bolts and Gaskets

Flange bolts are purchased under A. S. T. M. Specification A107, with regular unfinished square heads and heavy unfinished hexagon nuts. In rare cases where the bolts are inaccessible and subject to excessive corrosion, such as for fastening inlet gratings to the upstream face of a dam, stainless-steel bolts are used. The thinnest possible gasket consistent with the roughness of the flange, is used, with no gaskets over 1/16 in. Ring gaskets are used in preference to full-face gaskets as they make a tighter joint.



View of a pump bay at Chickamauga power house of TVA, showing station service, fire and water pumps and piping. Note use of OS&Y rising-stem gate valves. Regranulated cork insulation on valves and pumps, molded hairfelt on piping

Control Valves

Control valves are used by the Authority in hydro plants for pressure regulating, temperature regulating, pressure relief, and maintaining liquid level. Pressure-regulating valves are used for reducing the water pressure to generator air and oil coolers, turbine-oil coolers and runner seals, air-conditioning equipment, air-compressor jackets and aftercoolers, and general plant services. Where the pressure drop is low direct-operated spring-loaded diaphragm valves are installed, while pilot-operated valves are used for high-pressure drop. The pilot-operated valves are of the hydraulic or pneumatic type. The pneumatic type has proved more satisfactory for use on raw river water, as trouble has been experienced with the hydraulic type owing to fouling of the pilot valves, necessitating the installation of strainers in the pilot lines. We have found that filters installed in the air lines ahead of pneumatic valves are a good investment. Small valves and valves used for dead-end service are single-seated, while large valves are double-seated. A pressure gage is always installed on either side of a reducing station.

The sizing of pressure-regulating valves for hydro plants presents a problem because of varying headwater elevations. Since the valves must pass the required amount of water under any head condition, a valve large enough under low headwater may be too large under maximum headwater levels. Likewise a regulating valve on plant service sometimes must also be used for fire protection. This means that water requirements must be estimated very closely, and valves must be selected which have characteristics best suited for their particular service.

Two types of temperature-regulating valves are used, i.e., solenoid and motor-operated from a thermostatic element. Solenoid valves are used on air-compressor jackets and similar services to control cooling water so as to prevent flow and condensation when the service is intermittent. Motor-operated valves, actuated from thermostatic elements, are used on air-conditioning equipment and to control the cooling water to generator air coolers in remotely controlled plants.

Both spring-loaded hydraulic relief valves and diaphragm back-pressure valves have been used after pressure-regulating valves. Spring-loaded hydraulic relief valves are used in the small sizes and where the comparatively wide relief range is not objectionable. Diaphragm back-pressure valves have proved more satisfactory for large sizes and where close control is required. Relief valves are sized to pass the total amount of water which the pressure-regulating valve will pass under highest head conditions.

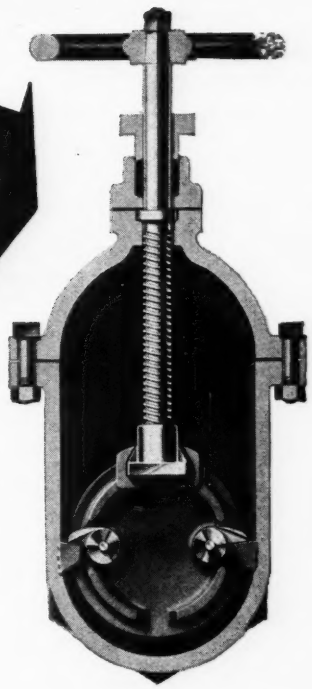
Level controls are used in open tanks and station drainage sumps, and for depressing tailwater in the draft tube when units are motored. The types used are the ordinary balanced float valve to maintain a constant level in an open tank from a pressure main, float-operated mercury switches and cam-type float switches to start and stop pumps, and diaphragm valves actuated by float-operated pilots and compressed air to depress tail-water in the draft tube when units are motored for condenser operation.

From paper entitled Design of Mechanical Auxiliaries for TVA Hydroelectric Plants, presented before Spring Meeting, ASME, Chattanooga, Tenn., April 1946. To be published in full in ASME Transactions.

Every feature you want in an

IRON BODY DOUBLE-DISC GATE VALVE

is in this KENNEDY DESIGN



It will pay you to study the operating mechanism of this Kennedy Standard Iron Body Double-Disc Gate Valve.

First notice its simplicity . . . it consists only of two discs, two cams and a stem nut.

When the valve is closing, the cams do not operate until the port opening is completely closed. The lugs on the body then engage with the arms on the cams, causing them to revolve, and forcing the two discs tight against the seats *at the exact moment of closure.*

When opening the valve, the first movement of the stem disengages the arms of the cams from the lugs in the body, immediately releasing the discs.

Then note these additional important advantages . . . location of actuating lugs well above the bottom of the valve to prevent sediment from interfering with correct operation . . . perfect operation with either disc toward the pressure, and with valve in any position . . . interchangeability of both discs and cams, so that mechanism cannot be assembled incorrectly.

This design, together with the many other Kennedy Valve types for all standard requirements, is fully described in the 240-page Kennedy Catalog which will be sent on request.

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NEWS from THE FIELD

EEI PERSONNEL CHANGES

Alexander Maxwell, director of engineering for Edison Electric Institute, has retired from service after more than 50 years' association with the electric utility industry. Succeeding Mr. Maxwell is Harry E. Kent. A. B. Morgan has been appointed assistant managing director of the Institute.

For a number of years Mr. Kent served as principal assistant to Mr. Maxwell and his entire professional career has been devoted to engineering activities of the Institute and its predecessor organization. Mr. Morgan previously was rate and power consultant for EEI, heading both the rate and general service departments.

MINERAL CONFERENCE DATE DEFERRED

Since formulation by the American Institute of Mining and Metallurgical Engineers of the original plans to hold the World Conference on Mineral Resources in New York City next September 16th to 18th, requirements for hotel accommodations for the United Nations have been increased to such an extent that it is now evident it will not be possible to accommodate the projected World Conference in New York at the same time. The Board of Directors of the A.I.M.E. has therefore voted to postpone the Conference and 75th Anniversary celebration until the week of March 17, 1947.

ASTM ANNUAL MEET

The intensive activity during the 1946 A.S.T.M. annual meeting held at The Statler Hotel, throughout the week beginning June 24 indicated the intensive interest in the Society's rapidly expanding work on specifications and tests for materials and methods of evaluating assemblies of these materials in various forms. The total registration for the week was 1825, second highest for this annual event, exceeded only by the 1944 Annual Meeting in New York where 2100 members and committee members attended.

The meeting was outstanding in many respects, notably in the quality and character of the technical sessions. There were eight symposiums with technical papers ranging in number from four to fifteen covering a wide diversity of fields. The topics covered included: Symposiums on Bearings, Gas Turbine Materials, Fatigue, Spectroscopic Light Sources, Oil Procurement Practices, Testing Parts and Assemblies, pH Measurements, Atmospheric Weathering of Corrosion-Resistant Steels, and Freezign-and-Thawing Tests of Concrete.

In addition to these symposiums, there were other sessions devoted to effect of temperature on metals, cement and concrete, plastics, non-ferrous metals, bituminous materials, and others, 25 separate sessions being required to provide adequate time for all the papers and reports. While possibly the Symposiums on Bearings, on Gas Turbine Materials, on Testing Parts and Assemblies, and on pH were outstanding, nevertheless, each was significant. It seemed apparent from the bearing symposium that there was a real desire on the part of those participating to share their technical "know how" in order that our knowledge of this field can be broadened and the development of new data accelerated.

The Symposium on Testing Parts and Assemblies was a joint one with the Society for Experimental Stress Analysis which held its meeting in Buffalo during the week of the A.S.T.M. meeting. In this field the A.S.T.M. has an administrative committee which is planning and supervising the expansion of the work as rapidly as possible so that there may result recommendations on how to evaluate materials when they are assembled in a structure.

ASM NOMINEES

The American Society for Metals recently announced five nominees for the Society's national officers and trustees for 1946-1947. Such nominations are tantamount to election.

Arthur L. Boegehold, head of the metallurgy department, Research Laboratories Division, General Motors Corporation, Detroit, incumbent vice president of the Society, was nominated for president. Francis B. Foley, vice presidential nominee, was graduated from Girard College and started his metallurgical career with Medvale Company, Nicetown, Philadelphia, Pa., in 1905.

William H. Eisenman, national secretary of ASM since its organization in 1918, was nominated for reelection for his 15th consecutive 2 year term. Dr. John E. Dorn, associate professor of physical metallurgy of the University of California, and Dr. Arthur E. Focke, research metallurgist of the Diamond Chain and Manufacturing Company, Indianapolis, were nominated for two year terms as trustees of the Society.

NATIONAL POWER SHOW TO BE COMPREHENSIVE

Exibitors' reservations for the 17th National Exposition of Power and Mechanical Engineering indicate that the display is destined to be the most comprehensive of its kind, as well as one of the largest ever held. With nearly all available space on four floors of Grand Central Palace, New York, already assigned, complete coverage of the power plant phase of industry is assured, although the dates of the Exposition, December 2-7 next, are still over four months away.

The Exposition is designed to serve the interests of consumers of power literally from the coal pile or oil

(Continued on page 140)

COMING EVENTS

American Chemical Society—National Chemical Exposition, sponsored by the Chicago Section of the Society; to be held September 10 to 14, in the Chicago Coliseum.

National Chemical Exposition—Biennial Exposition, sponsored by Chicago Section of American Chemical Society; to be held September 10 to 14 in Chicago Coliseum.

Instrument Society of America—"Instrumentation for Tomorrow" exhibit; to be held in Pittsburgh at the Hotel Wm. Penn, September 16 to 20.

American Society of Mechanical Engineers—Instruments and Regulators Committee; meeting to be held in Pittsburgh at the Hotel Wm. Penn, September 16 to 20.

National Electronic Conference—Conference sponsored by Illinois Institute of Technology, Northwestern University and the Chicago Sections of AIEE and IRE; to be held at the Edgewater Beach Hotel in Chicago, October 3 to 5.

American Welding Society—1946 annual meeting to be held in New York City, October 24; headquarters not yet announced.

Seventh Annual Water Conference—Sponsored by the Engineers Society of Western Pennsylvania; to be held in Pittsburgh October 28 to 30, with headquarters at the Hotel William Penn.

Refrigeration, Air Conditioning Show—Sponsored by Refrigeration Equipment Manufacturers Assn.; to be held in Cleveland, October 29 to November 1, in the Public Auditorium.

American Welding Society—1946 annual meeting (reassembly) to be held in Atlantic City, November 17 to 22; headquarters at Municipal Auditorium.

National Metal Congress and Exposition—To be held in Atlantic City, November 17 to 22, headquarters at Municipal Auditorium.

Power Show—17th National Exposition of Power and Mechanical Engineering; to be held in New York City, at the Grand Central Palace, December 2 to 7.

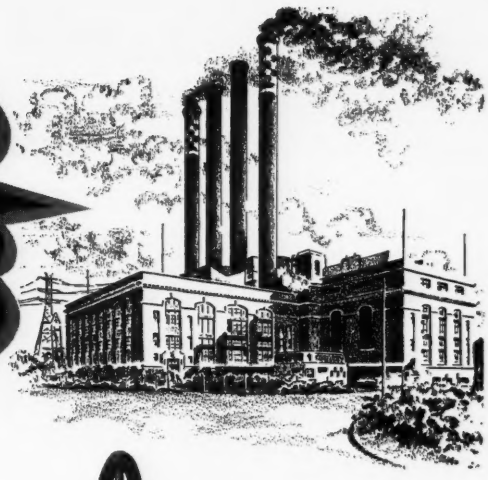
ASME—American Society of Mechanical Engineers; mid-winter meeting, to be held December 2 to 7.

Heating and Ventilating Exposition—7th International Heating and Ventilating Exposition; to be held January 27 to 31 in Cleveland at Lakeside Hall.

Electrical Engineering Exposition—Annual show (Postponed since 1941) to be held in New York City, January 27 to 31; headquarters at 71st Regiment Armory, Park Ave. and 34th St.

AIEE—American Institute of Electrical Engineers; winter convention to be held January 27 to 31.

VALVES designed for the modern Power Plant



Years ago, when American Industry was still in its infancy, The Wm. Powell Company adopted a definite, farsighted policy . . . to concentrate on making valves only—valves of *every* design, for *every* service in *every* branch of industry.

That is why, today, Powell can supply valves to meet every known flow control requirement in your plant. And, if you have any flow control problems, Powell Engineers will gladly help you solve them.

Catalogs gladly furnished on request. Kindly state whether you are principally interested in Bronze, Iron or Steel Valves.

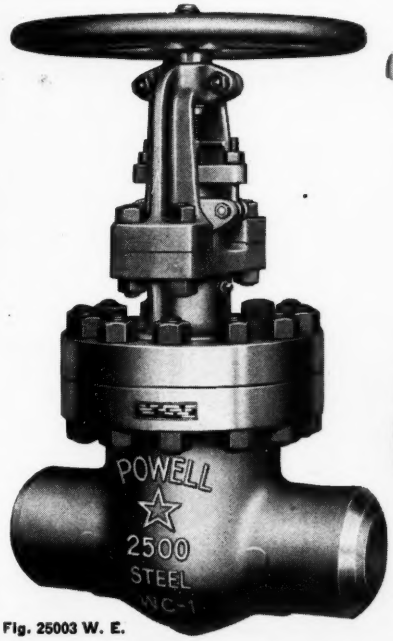


Fig. 25003 W. E.

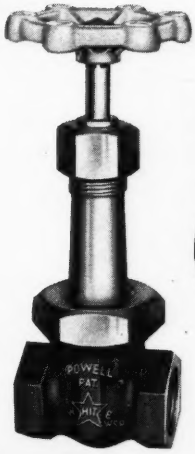


Fig. 375

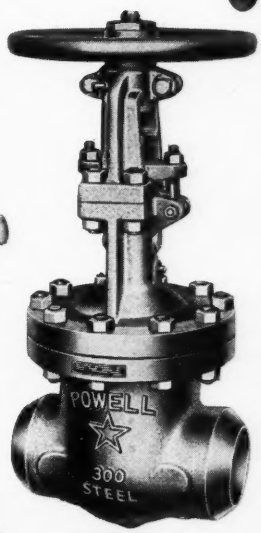


Fig. 3003 W. E.

Fig. 25003 W. E.—Class 2500-pound Cast Steel Welding End O. S. & Y. Gate Valve.

Fig. 375—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel bronze disc.

(Above) Class 900-pound, 12" Welding End Cast Steel Non-return Angle Valve. Toggle operated.

Fig. 3003 W. E.—Class 300-pound Cast Steel Gate Valve with welding ends, outside screw rising stem and bolted flanged yoke.

The Wm. Powell Company, Cincinnati 22, Ohio

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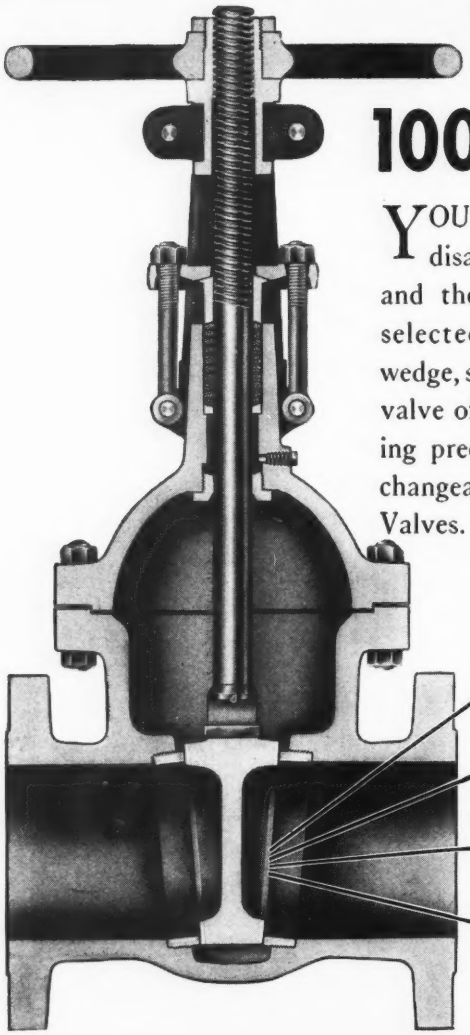
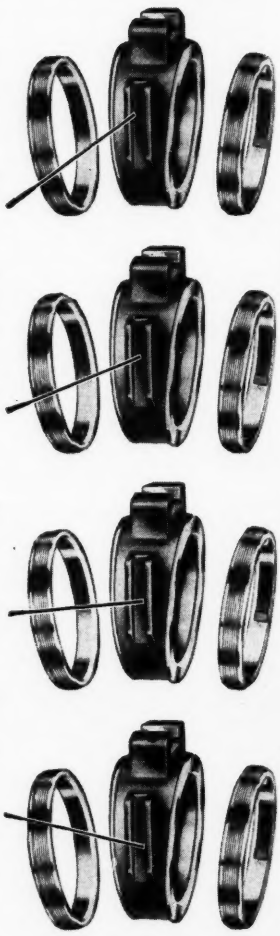
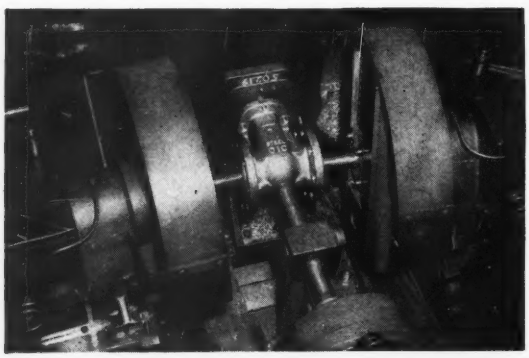


The *Same* Precision 100 times in 100 valves

YOU can take 100 OIC Steel Valves, disassemble them, shuffle the parts, and then reassemble them with parts selected at random. Any seat ring, wedge, stem, bushing, or yoke nut fits any valve of its size and type. This unvarying precision which makes parts interchangeable is a regular feature of OIC Valves. We developed the machinery that makes this possible. This machinery is found in only one plant — the OIC plant at Wadsworth, Ohio.

Uniform precision is one of the many reasons why OIC Valves improve valve performance in the complete range of applications for your industry. Your OIC Distributor can give you added reasons. He has a complete line of globes, gates, angles, and checks — iron, bronze, and steel — all types and sizes.





Only at OIC

This machine which automatically achieves identical precision on each part eliminates the common practice of "custom" fitting individual wedges to each pair of seat rings. It is an exclusive OIC development which insures better valve performance.

OIC VALVES

THE OHIO INJECTOR COMPANY, WADSWORTH, OHIO

CONSTANT SUPPORT OF PIPING

AT AVON . . . MARTINEZ . . . OLEUM

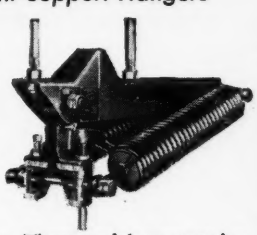
From boilers to turbines Grinnell Constant-Support Hangers "float" the piping at three Pacific Gas and Electric Power Plants. These hangers carry all the load all the time to satisfy the conditions of expansion, contraction and vibration.

GRINNELL CONSTANT SUPPORT HANGERS

— the ONLY Constant-Support Hangers

FEATURES:

- Constant Support of piping in all "Hot" and "Cold" positions.
- Full safety factor of the supported system is always maintained.
- Non-resonant, energy absorbing.
- Mass-produced from standard precision parts.
- Individually calibrated for each installation.
- Load-adjustment features incorporated into the design.



- Three models meet entire range of load-travel specifications.
- Minimum headroom required.

Write for data book containing complete details.

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GRINNELL

WHENEVER PIPING IS INVOLVED

ATLAS

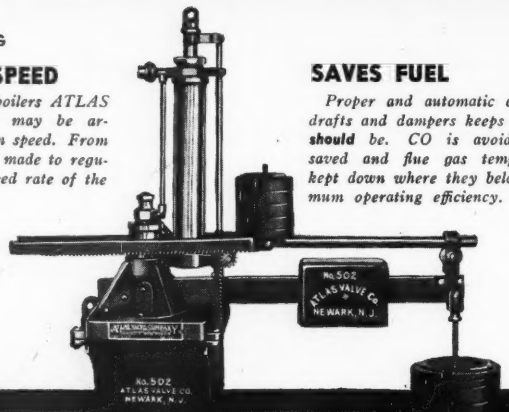
TRADE MARK REG

CONTROLS SPEED

On forced draft boilers ATLAS Damper Regulators may be arranged to control fan speed. From the fan they may be made to regulate indirectly the feed rate of the stokers.

SAVES FUEL

Proper and automatic adjustment of drafts and dampers keeps CO_2 where it **should** *be. CO is avoided. Fuel is saved and flue gas temperatures are kept down where they belong for maximum operating efficiency.*



Damper Regulators

ATLAS Damper Regulators are recommended for use where correct steam pressure is important, as follows:

For low pressure boilers we recommend No. 501 which is suitable for automatically regulating drafts on vapor or low pressure steam heating boilers. Can be adjusted to operate at any steam pressure up to 25 pounds.

For medium pressure boilers we recommend No. 502, pictured above. For pressures up to 150 pounds. Will move damper on boiler pressure changes of ¼ pound.

For high pressure boilers we recommend No. 503. This regulator has a Cast Iron Base construction for boiler pressures up to 250 pounds. Cast Steel Base construction for boilers up to 400 pounds. Will move damper on ½ pound boiler pressure variations.

ATLAS Damper Regulators are automatic—hydraulic—sensitive—easy to install. Water pressure is made to act automatically on a piston which is connected to draft doors or dampers by chain. Ample power is thus available for moving the heaviest doors or dampers. At the same time the control piston responds to slightest variations in steam pressure so that uniform pressure is maintained through closest adjustment of dampers and a resulting steady rate of combustion.

ASK for BULLETIN 4-A

This Bulletin explains why ATLAS Damper Regulators are so valuable on boilers of practically every type and size. For other ATLAS power plant products check the list below, clip out, attach your name and address, and you will hear from us promptly.

☐ Please send Bulletin 4-A. Also please send information on the following ATLAS products—

☐ Campbell Boiler Feed Water Regulators
☐ Temperature Regulators
☐ Reducing Valves
☐ Exhaust Control Systems
☐ Pressure Regulators
☐ Pump Governors
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☐ Humidity Controllers
☐ Thermostats
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tank to the machine tool or processing operation. Some phases of power utilization are also included. The power phase, wholly or in part, is common to all forms of industry. Thus the Exposition, which is held biennially, attracts visitors, especially at the executive and management levels, from every imaginable field of activity.

An impressively long list of innovations is promised for the forthcoming display, giving effect to new technical knowledge, experience and scientific developments gained by exhibitors during the war years. Many inventions, held back during the period of curtailed initiative, are now being readied for release. Much equipment has been redesigned to utilize improved materials and better designs. By the end of the year it is expected that manufacturers of power equipment will be in full swing production, though it may be many months before some of them make a sizable impression on the back-log of accumulated orders.

NEW CONSULTING FIRM

Clayton N. Ward and John A. Strand announce that they have formed a new firm of consulting engineers under the name of Ward and Strand. The temporary address is 550 State St., Madison 3, Wis.

Mr. Ward, after two years of teaching at the University of Michigan and ten years at the Engineering School of the University of Wisconsin, was employed by the engineering firm of Mead and Seatone. In 1932 he was Wisconsin State Director of the Civil Works Administration. From 1933 to 1946 he has been a partner and chief engineer in the firm of Mead, Ward and Hunt.

Mr. Strand graduated from the Engineering School of the University of Wisconsin in 1932 and has worked with the Soil Conservation Service, Wisconsin Highway Commission, Consoer, Townsend & Associates of Chicago, and has been with Mead, Ward and Hunt since 1936.

The firm will engage in engineering projects involving water, diesel and steam power; water works; sewerage works; flood control; irrigation and drainage; hydraulic research; and hydrological investigation.

CED TO INTENSIFY RESEARCH

ELECTION OF 53 new Trustees of the Committee for Economic Development was announced recently. This increase in the membership of the Board is a first step in the reoriented CED program, which calls for intensifying and accelerating research on problems bearing on the maintenance of high levels of production, distribution and employment.

All of these new members, together with the present twenty-six trustees who will continue in office, are convinced of the urgent need for business to develop responsible policy recommendations based on objective research which will contribute to the maintenance of high level employment within the framework of a free society.

Commenting on the work facing CED, Paul G. Hoffman, chairman, said: "For the three years prior to V-J Day CED, operating as a private,

You Know They're in to Stay..

When You Install LADISH Controlled Quality FORGED STEEL FITTINGS

Yes, you know they're in to stay when you install Ladish *Forged Steel* Fittings. No more worry about premature failures and consequent crippling shutdowns . . . because Ladish *Forged Steel* Fittings are characterized by the extra strength and toughness that result from advanced *drop forging* procedures.

The rugged, reinforced design combines with a more compact grain structure and accurately controlled grain flow to produce a fitting that resists erosion, shock, strains and stresses common in piping systems.

Ladish Forged Steel Fittings are manufactured under painstaking metallurgical controls with full accurate threads (or deep welding sockets) precision machined for protection against leakage and for ease of installation. Ladish Fittings undergo a rigid inspection for dimensional tolerances, physical soundness and metallic composition. Thus *each* user of Ladish Fittings is assured consistent *Controlled Quality.*

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Distinguished by corrosion-resisting Ladish green paint . . . permanent steel identity . . . size and pressure specifications.

The Stuffing Box

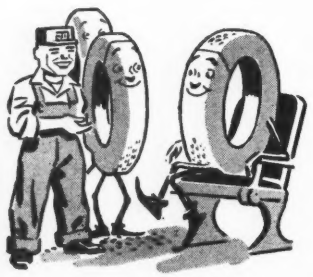
TIPS ON GOOD PACKING PRACTICE

NO. 3 OF A SERIES

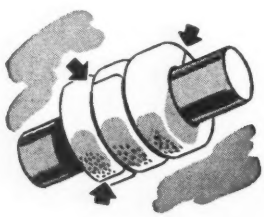
Previous issues of "The Stuffing Box" have included pointers on inspection and tips on preparing the new packing for installation. Now we're ready to go ahead with the actual re-packing job.

(**Note:** If you missed Numbers 1 and 2 in the Stuffing Box series, write today to Johns-Manville for free copies—see address below.)

Here are three simple rules that will help make any packing job last longer:



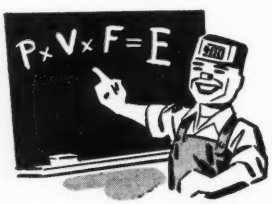
1. Seat each packing ring carefully before placing the next one in the box. Avoid loading the box with packing and then pulling up on the gland follower. This practice often results in jamming and deforming the last rings inserted and building up excessive gland pressure on these rings. There is also the danger that the bottom rings may not be seated properly.



2. Install the rings so that the joints are staggered and kept approximately 90 deg. apart. Thus each joint is sealed by the packing ring next to it.

3. Pull up the gland follower sufficiently tight to insure final seating of the packing. To make sure the gland isn't cocked, tighten the nuts alternately, first on one side, then on the other. Then slacken off and leave them finger-tight. Further adjustments should be made after the pump has been in operation.

Let the packing leak a little if possible. It is good assurance that the packing is not too tight, and the liquid usually has some lubricating qualities. If leaking can't be permitted, arrange to introduce a sealing or lubricating fluid into the stuffing box as recommended by many pump manufacturers. Water, oil or grease will do the trick.



Think of the stuffing box as a potential brake assembly that may develop considerable frictional resistance. Pressure, times velocity in feet per minute, times coefficient of friction, is a rule of thumb measure of the energy absorbed. Use lubrication to minimize friction.

Finally, keep the packing clean, before, during and after the re-packing job. Wrap up any extra rings and place them in their container so they won't pick up grit or other foreign matter that might score when it comes into contact with a shaft or rod.

And next time you need a packing, remember there are 400 conveniently located Johns-Manville Distributors throughout the country ready to supply the right one for your job.

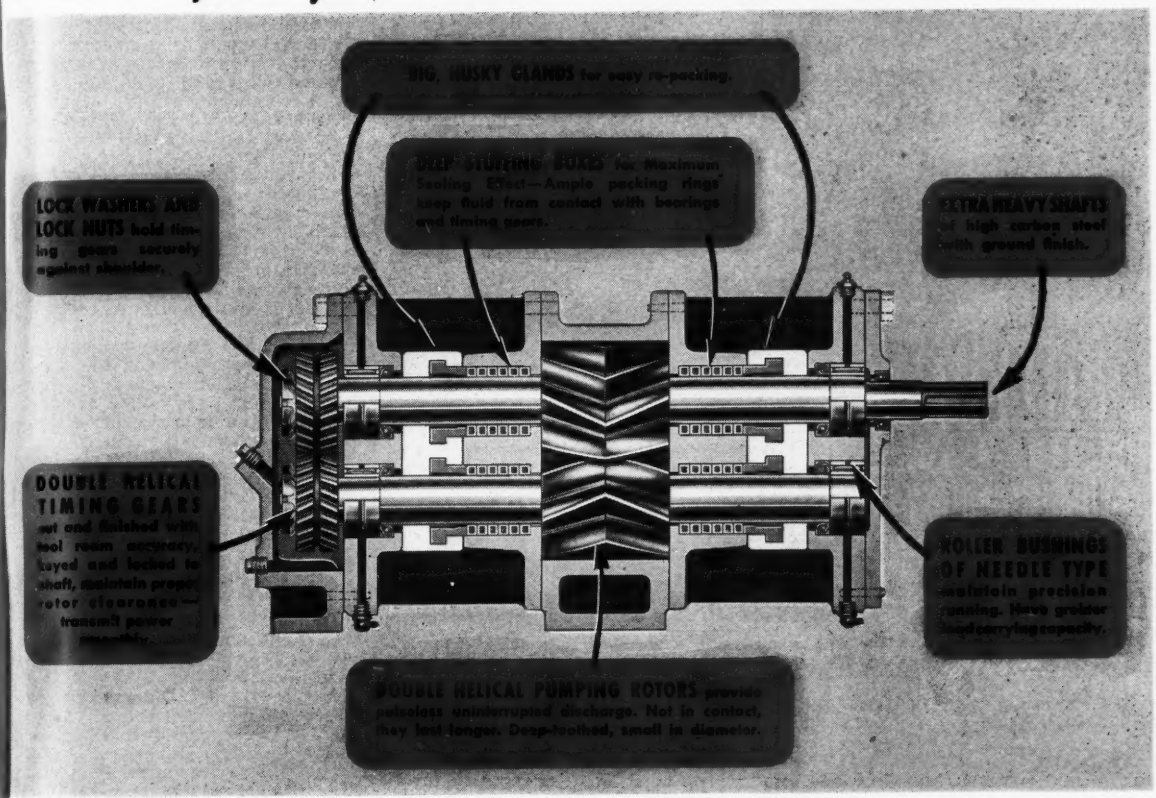
It's good practice to use Johns-Manville

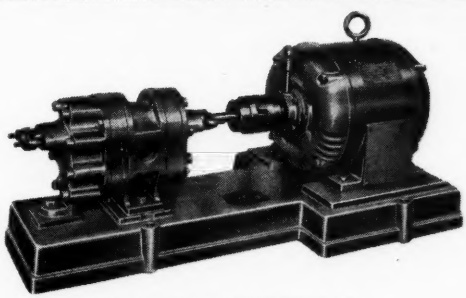
KEARSARGE ROD PACKING

When you need a long-wearing rod and plunger packing for service up to 500° F., use Kearsarge. Its unique folded construction forms a reservoir for the preserving lubricant, keeps this packing pliable in service and makes it last longer. Kearsarge is especially recommended for use on reciprocating rods of steam engines, pumps, compressors, etc., where the packing space is ⅛" or more. It may also be used against air and gas. See your distributor, or write Johns-Manville, Box 290, New York 16, N. Y.

GEAREX ROTARY PUMPS

Give you these PLUS VALUES


BIG, HUSKY GLANDS for easy re-packing.
DEEP STUFFING BOXES for Maximum Sealing Effect—Ample packing rings keep fluid from contact with bearings and timing gears.
LOCK WASHERS AND LOCK NUTS hold timing gears securely against shoulder.
EXTRA HEAVY SHAFTS of high carbon steel with ground finish.
DOUBLE HELICAL TIMING GEARS cut and finished with tool room accuracy, keyed and locked to shaft, maintain proper rotor clearance—transmit power smoothly.
ROLLER BUSHINGS OF NEEDLE TYPE maintain precision running. Have greater load carrying capacity.
DOUBLE HELICAL PUMPING ROTORS provide pulseless uninterrupted discharge. Not in contact, they last longer. Deep-toothed, small in diameter.



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DISCHARGE: 250 p.s.i. for medium or high viscosities. 50 p.s.i. for water

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For higher pressures and capacities use
SIER-BATH SCREW PUMPS

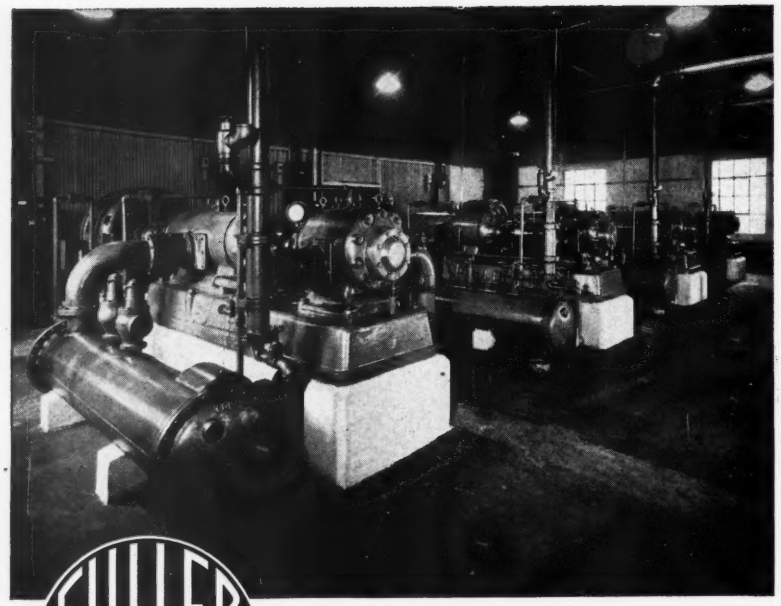
SIER-BATH Gearex Rotary Pumps last longer and run quieter because they are made to the same high accuracy standards as Sier-Bath Precision Gears. Their low pitch line speed results in more efficient operation. Their special design prevents trapping. Sier-Bath Gearex Pumps are available in horizontal and vertical models, in steel or special alloys, and with jacketed bodies for high temperature applications or where heat must be applied. Write for detailed information.

See our Booth No. 568 at the Power Show in Grand Central Palace, New York, in December

FOUNDED 1905 **MEMBER OF A. G. M. A.**

Sier-Bath Gear Co. Inc.

SIER-BATH GEAR COMPANY, INC.

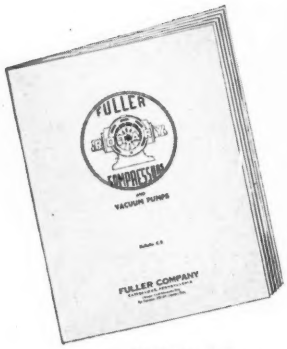


FULLER ROTARY COMPRESSORS

Four Fuller Rotary Two-stage Compressors, each having a capacity of 1665 c.f.m., 100-lb. pressure.

In A Steel Mill

Hundreds of Fuller Rotary Compressors are in service in the metal industries, working 24 hours a day, day after day, month in and month out, with low maintenance expense . . . that's why plant superintendents and maintenance men like them. There's a very good reason for this excellent performance because Fullers have very few moving parts to wear or adjust. Another very important feature always to be considered . . . *due to their design Fuller Rotaries will maintain their original capacity for the life of the machine.*

Fullers are built for capacities to 1800 c.f.m., pressures to 100-lb. Write for Bulletin C-5 illustrating and describing these machines.

Bulletin C-5
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C-121

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

non-profit, non-political organization financed by contributions from business, had two objectives. The first was to help individual businessmen to plan during the war for quick reconversion and expanded operations after victory. The CED Field Development Division, responsible for this task, organized and serviced nearly 5,000 local community committees with a membership of more than 70,000 businessmen.

"There is general agreement that the activities of these committees contributed substantially toward attaining the high employment which has prevailed since V-J Day. With its task completed, the national Field Development Division was disbanded in February of this year.

"The second CED objective was to help create an economic climate favorable to the attainment and maintenance of high productive employment. For this purpose the Research Division was organized. Up to the present time its studies have been concerned largely with the transitional problems. It has just begun to tackle such long range questions as the special problems of small business, the problems of wage price policy and those of coordinating government fiscal and monetary policies. Its most ambitious prospective undertaking is an effort to find an answer to the sixty-four dollar question: what can and should a government of a free people do to promote national prosperity?"

ASA YEAR BOOK

The American Standards Assn. recently announced publication of its 1945-46 Year Book. This is the first Year Book published by the Association since 1938. It, therefore, contains much new material of value to engineers, executives, and technical students.

The book gives information about officers and members of the Board and Directors, of the Standards Council, and other policy forming committees of the American Standards Association. It also carries such basic documents as the Constitution and By-Laws of the ASA; and much information about the set-up of the organization and how standards are developed.

The center section of the book is devoted to a listing of approved American Standards and projects under development together with the scopes of these projects and names of officers and members of active technical committees.

Those interested may obtain copies of the Year Book free of charge by writing to the American Standards Association at 70 East 45th Street, New York 17, N. Y.

SMITH NEW CHIEF E. E. OF SARGENT & LUNDY

Francis H. Hollister, partner and Chief Electrical Engineer of Sargent & Lundy, retired as of June 30, 1946.

Mr. Hollister joined the staff of Sargent & Lundy in 1916, and in 1930 became Chief Electrical Engineer. Mr. Hollister is a Fellow and Member for Life of the American Institute of Electrical Engineers. He has served on a number of committees of the Institute, being Chairman of the

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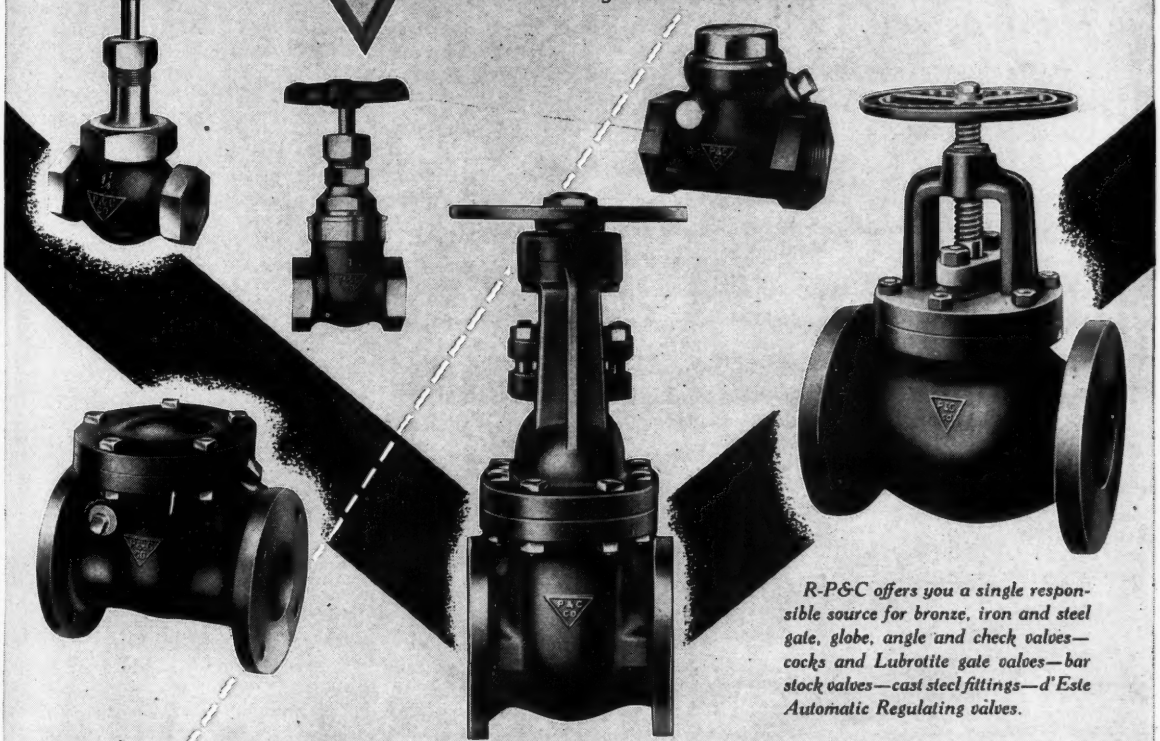

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POWER PLANT ENGINEERING

Power Generation Committee in 1935-36. Mr. Hollister is a member also of the Western Society of Engineers.

Frank V. Smith, a partner of Sargent & Lundy, has been appointed Chief Electrical Engineer of the firm, to succeed Mr. Hollister.

Mr. Smith became a member of the staff of Sargent & Lundy in 1927 and on January 1, 1945, became a partner and Assistant Chief Electrical Engineer of Sargent & Lundy. Mr. Smith is a Member of the American Institute of Electrical Engineers and has served as Chairman of the Chicago Section; also on a number of national committees.

DOMESTIC CONSUMERS NOT RESPONSIBLE FOR AS MUCH SMOKE AS BELIEVED, SAYS LAMMERS

THE CHARGE frequently made that 70 to 80 per cent of the smoke in our cities is caused by the domestic consumer was refuted by H. B. Lammers, Director of Engineering of the Coal Producers Committee for Smoke Abatement before the Smoke Prevention Association of America Convention on June 26th.

Mr. Lammers presented compilation of sootfall records from Cincinnati, Rochester, Chicago and New York City. The percentage of "fall-off" of the soot fall tonnage between the heating and non-heating months for the various cities was as follows:

City		Entire City	Period
Cincinnati	(1)	17.7	1939-45
Rochester	(2)	25.5	1937-42
Chicago	(3)	17.0	1935-45
New York	(4)	23.0(a)	1946

(1) Sootfall records furnished by C. Gruber, Chief Smoke Inspector, Cincinnati, Ohio.
(2) Sootfall records furnished by E. B. Brundage, Chief Smoke Inspector, Rochester, N. Y.
(3) "Clean Air for a Big City" by Henry T. Held, President, Illinois Institute of Technology (Meeting Chicago Assn. of Technology 3/28/46).
(4) "Air Pollution in New York City" by Arthur C. Stern, M. E., Leon Buchbinder, Ph.D., and Jac Siegel, B.S. and others. Reprinted from ASHVE Journal Section, Heating, Piping and Air Conditioning, July, August, September, and October-November, 1945.
(a) A pre-war year—sootfall "fall-off" in percent for the following suburbs: Bronx, 20%; Queens, 16%; Richmond, 15%; New York City total 23%.

"If we, therefore, assume for the sake of argument that all this polution or smoke is to be charged to heating by the domestic consumer then it follows that the maximum fall-off, if all heating were discontinued, would be 20.8 per cent—not 70 to 80 per cent as many authorities claim," said Mr. Lammers.

"It is readily apparent," continued Mr. Lammers, "that by no stretch of the imagination can all this 20.8 per cent be charged to the domestic consumer of fuel because many other industrial and commercial establishments also use fuel for heating. Again let's assume, for the sake of argument, that all high volatile coal was burned and replaced with low volatile. For the sake of argument let's assume that low volatile

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- ☐ Float Valves
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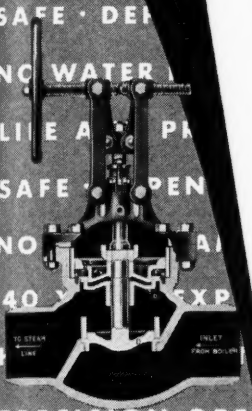

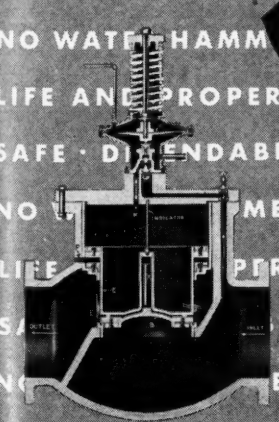
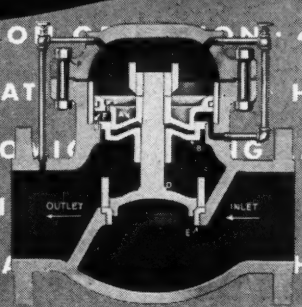

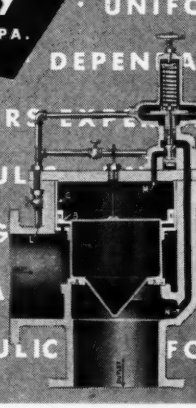

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coal would reduce the smoke emitted by 50 per cent. We would end up with a total net reduction in sootfall of 10 per cent—if all fall-off were charged to the domestic consumer—which 10 per cent would be barely noticeable in our general atmospheric improvement."

"It, therefore, seems to the Coal Producers Committee for Smoke Abatement that the logical approach to the smoke problem would be not in the order of passing legislation to get rid of the 5 to 10 per cent of the smoke but rather that the immediate solution is to tackle the remaining 90 per cent. The ultimate solution to the smoke emitted by the domestic consumer lies in improved equipment to burn coal smokelessly and more efficiently, rather than impose an economic hardship on the community and legislate an organization out of business," Mr. Lammers concluded.

AIEE OFFICERS

J. Elmer Housley, District Power Manager, Aluminum Company of America, Alcoa, Tenn., was elected president of the American Institute of Electrical Engineers for the year beginning August 1, 1946, as announced at the annual meeting of the Institute held in Detroit, June 26. The other officers elected were: Vice Presidents E. W. Davis, Cambridge, Mass.; O. E. Buckley, New York, N. Y.; T. G. LeClair, Chicago, Ill.; R. F. Danner, Oklahoma City, Okla.; C. F. Terrell, Seattle, Wash., Directors J. F. Fairman, New York, N. Y.; R. T. Henry, Buffalo, N. Y.; E. P. Yerkes, Philadelphia, Pa., Treasurer W. I. Slichter, Schenectady, N. Y. (re-elected).

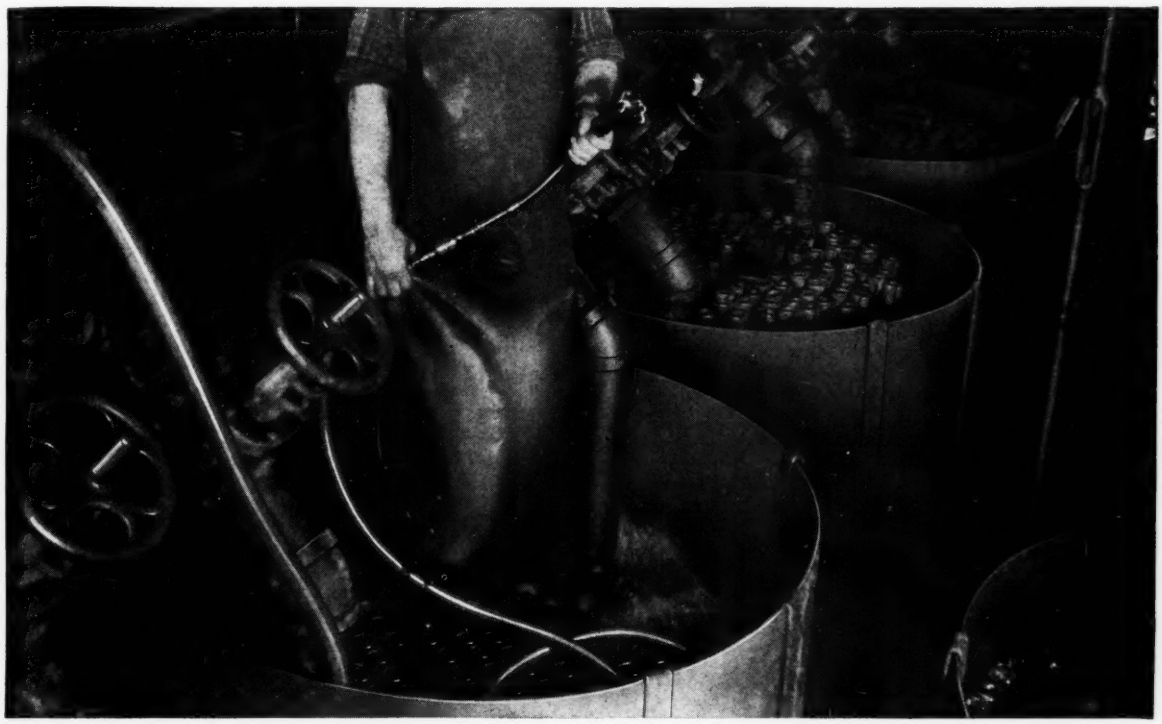
These officers, together with the following hold-over officers will constitute the Board of Directors for the next administrative year, beginning August 1, 1946: W. E. Wickenden, Cleveland, Ohio (retiring president); C. A. Powel, East Pittsburgh, Pa. (junior past president); P. L. Alger, Schenectady, N. Y.; F. F. Evenson, San Diego, Calif.; E. S. Fields, Cincinnati, Ohio; J. M. Flanigen, Atlanta, Ga.; C. M. Laffoon, East Pittsburgh, Pa.; F. L. Lawton, Montreal, Que.; M. J. McHenry, Toronto, Ont.; C. W. Mier Dallas, Texas; S. H. Mortensen, Milwaukee, Wis.; J. R. North, Jackson, Mich.; D. A. Quarles, New York, N. Y.; L. M. Robertson, Denver, Colo.; Walter C. Smith, San Francisco, Calif.; H. B. Wolf, Charlotte, N. C.

The annual report of the Board of Directors, presented at the meeting, showed a total membership on April 30, 1946, of 25,090.

ASHVE STUDIES VENTILATION

A long range research program has recently been inaugurated as a result of the common interest of the American Society of Heating and Ventilating Engineers and the U. S. Public Health Service in industrial ventilation. Last October, to assure more efficient correlation of the activities of these two groups, Dr. A. D. Brandt of the U. S. Public Health Service was assigned to the A. S. H. V. E. Research Laboratory, Cleveland, Ohio.

Your Condensers Last Longer When APEXIOR NUMBER 3 Keeps the Metal Dry



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To prepare for APEXIOR NUMBER 3, clean surfaces thoroughly to bare metal — sandblast if possible — then apply two coats of APEXIOR NUMBER 3 like a paint, using a hand brush. An original abrasive blast cleaning (never again necessary) prepares for a permanent maintenance base upon which APEXIOR protection can be established. For internal surfaces of tubes, special brush equipment is available for use with standard air turbines. APEXIOR NUMBER 3 is shipped ready-for-use — no thinner permitted.

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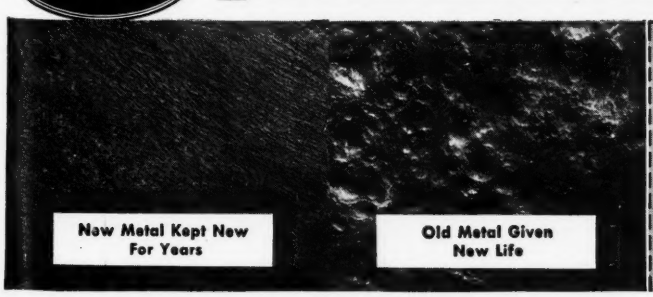

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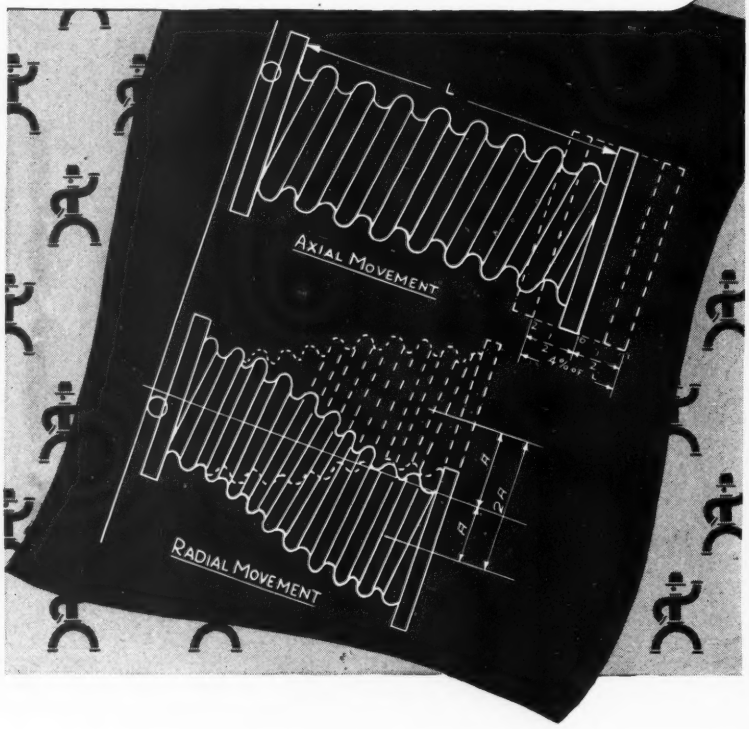

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Obituaries

WILLIAM HENRY DELL

Engineers in the Philadelphia area were shocked to learn of the sudden death of William Henry Dell on July 25. Mr. Dell had spent the past 25 years in the employ of Gulf Oil Corp. where he functioned as both plant engineer and superintendent of power at the Girard Point Refinery in Philadelphia. During this period the project grew from a bulk plant with four small boilers to a full-fledged refinery generating almost a million pounds of steam per hour.

Born in Mannheim, Germany, 54 years ago, Mr. Dell came to America as a young man and studied in a number of technical schools. He soon obtained a marine engineer's license and was employed as a Quarterman at New York Shipbuilding Corporation of Camden, N. J., immediately after the First World War. Then came the connection at Gulf Oil Corporation, which he retained without interruption to the time of his death.

The deceased was a member of American Society of Mechanical Engineers. He is survived by his wife, Caroline, and three brothers, all of whom hold executive positions in kindred enterprises.

E. M. RUST

Ellsworth Marshall Rust, 67, vice-president of The Rust Engineering Co., died at his Leesburg, Va., home on July 24. Mr. Rust was the son of Col. Armistead S. Thomson Mason Rust and Ida Lee Rust. He received his education at Virginia Military Institute.

In 1905 with his brothers E. J. Lee Rust and S. Murray Rust, he founded The Rust Engineering Co., of Pittsburgh, Birmingham, Washington, D. C., and New York. He has been continuously connected with the company as vice-president. He was also vice-president of Rust Furnace Co., Pittsburgh, Pa., and the Bolivar Clay Products Co., Boliver, O.; and president of Woodbridge Clay Products Co. of Woodbridge, Va. He was treasurer of the Associated General Contractors of America for many years.

Mr. Rust is survived by his sister, Mrs. Ida Lee Follett, and his brother, S. Murray Rust of Leesburg.

Eric E. Sommer

ERIC E. SOMMER, Sales Engineer with The Linde Air Products Co., New Products Division, was one of the victims of the disastrous fire which swept the La Salle Hotel in Chicago. He was 34 years of age.

Mr. Sommer was born in Hove, England in 1912. His parents brought him to this country as a child. He attended high school in Buffalo, N. Y., and received his B. S. degree in Chemical Engineering from the University of Michigan in 1935.

Mr. Sommer has been with The Linde Air Products Co. since 1935. Employed as an associate engineer at the Tonawanda, N. Y., plant, he later became assistant to the Research

DISSOLVED OR ENTRAINED AIR

in circulating water—one of many factors governing condenser tube and heat exchanger tube performance—is presented in this discussion by Scovill engineers on selection of the proper tube alloy.

Fast-flowing rivers, rapidly changing tides, spray ponds and moving ships all create a condition causing entrainment of air. Furthermore, all raw water is saturated with dissolved air. Approximately **2.7** cu. ft. of air will dissolve in 1000 gal. of water — the quantity of air to saturate being dependent on the water pressure, composition and temperature. Any low-pressure areas in the circulating system permit the liberation of part of this dissolved air to ally itself with any free air in its erosive-corrosive attack on the tubes.

In actual operating conditions, where dissolved or entrained air in the circulating water is only one of the variables, tube life depends on the nature and/or extent of such other factors as: Velocity and turbulence of coolant . . . Chemical composition of circulating water . . . Temperatures inside and outside of tubes . . . Chemical or electro-chemical actions . . . Marine growths or other deposits . . . Sewage and wastes present . . . Development of protective film . . . Media surrounding tubes.

One of the principal objects of Condenser Tube Technical Research has been the development of alloys designed to give the user longest tube life and most trouble-free service. Where the major factor affecting tube life is the presence of dissolved or entrained air, satisfactory alloys include Cupro-Nickel, Aluminum Brass and Phosphorized Admiralty, each within its temperature limitations.

So many variables surround any condenser or heat exchanger tube application that each case must be treated as an individual problem.

Data accumulated during Scovill's continuous study of condenser and heat exchanger tube service conditions for every known application equip its Technical Service Department to offer sound guidance in tube alloy selection for existing or proposed installations.

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Scovill's *Service in Men* offers experienced engineering to help solve your tube selection and installation problems. *Service in Metals* develops and produces Scovill tube alloys that conform to your requirements. *Service in Manuals* consists of literature which gives you latest, authentic information on condenser and heat exchanger tubes. For a free copy of Condenser Tube Booklet, address Scovill Manufacturing Co., 17 Mill St., Waterbury 91, Conn. *Export Dept.* 405 Lexington Ave., New York 17, N. Y.

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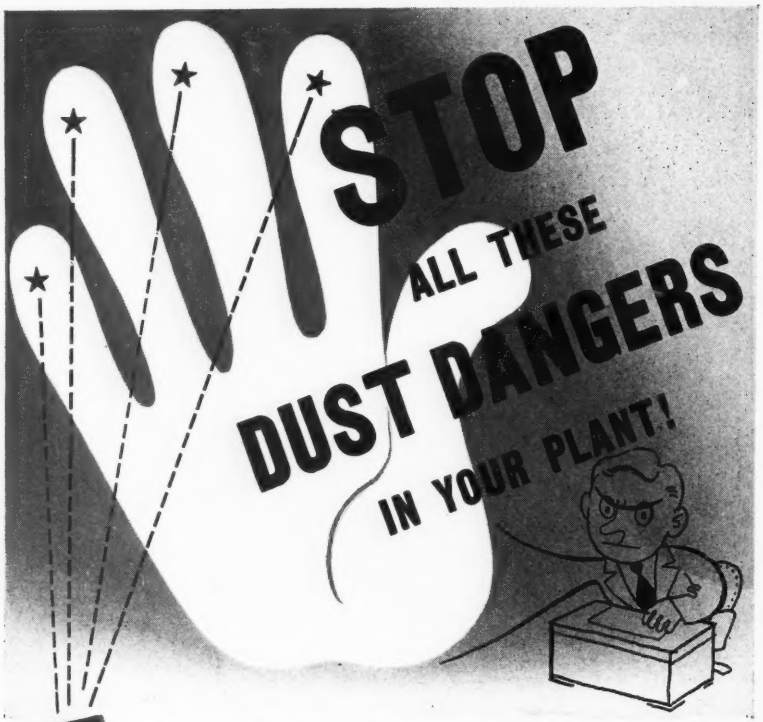

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Manager, and then was transferred to the New York Office. He was made a Sales Engineer for the New Products Division of the Company in April, 1945, which position he held at the time of his death. He was a member of the American Institute of Chemical Engineers.

Mr. Sommer is survived by his wife, Nancy, his three-year old daughter, Barbara, his parents, Mr. and Mrs. Emil Sommer of Buffalo, N. Y., and a sister, Mrs. Frank James of Huntsville, Ala.

CHARLES E. CUMMINGS

Charles E. Cummings, assistant secretary of Raybestos-Manhattan, Inc., died June 6 at the age of 79. Mr. Cummings was one of the 52-year Pioneers of the Manhattan Rubber Division, Passiac, N. J., and was probably the one with the longest number of years in the rubber industry, having started in 1881.

Born in Brooklyn June 27, 1867, Mr. Cummings first entered the rubber industry in 1881, when he became employed at the New York office of the New York Belting and Packing Co. He joined Manhattan Rubber as a bookkeeper in the New York office April 16, 1894.

MANUFACTURERS' *News*

DE LAVAL'S NEW OFFICES

The De Laval Separator Co. announces the opening of two new offices—one in Minneapolis at 7212 Oak Grove Boulevard, and one in Kansas City at 4746 Roanoke Parkway. Both will be under the jurisdiction of the Chicago headquarters. The Kansas City office will be in charge of P. W. Perry. The Minnesota office will be in charge of R. E. Thrush.

HAERING ANNIVERSARY

The current issue of H-O-H Lighthouse recognizes the Fifteenth Anniversary of D. W. Haering & Co., Inc. In addition two interesting and informative articles acquaint the reader with several common and uncommon applications of these organic chemicals to widely diversified water-treating problems.

Copies may be had by requesting them on your company letterhead from D. W. Haering & Co., Inc., 205 Wacker Drive, Chicago 6, Illinois.

SMA OFFICERS

The Stoker Manufacturers Assn., at its annual meeting at Colorado Springs, elected the following officers: president, Walter Sormane, Conco Engineering Works; vice president, George W. Graham, Eddy Stoker Corp.; secretary-treasurer, Claude A. Potts, U. S. Machine Corp.; staff officials, Marc G. Bluth, executive secretary and Lloyd L. Connell, technical director.

Following is the board of directors in addition to the first three officers named above: C. T. Burg, Iron Fireman Mfg. Co.; F. H. Herndon, Link-

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Here's a wide range of equipment to meet every need: TEXROPE Vari-Pitch sheaves for stationary or motion control — TEXROPE Wide-Range Vari-Pitch Sheaves and V-Belts — Speed Changer units. Speed variations up to 375% are possible. Ask your nearest Allis-Chalmers office or dealer for bulletin No. B6082-A.

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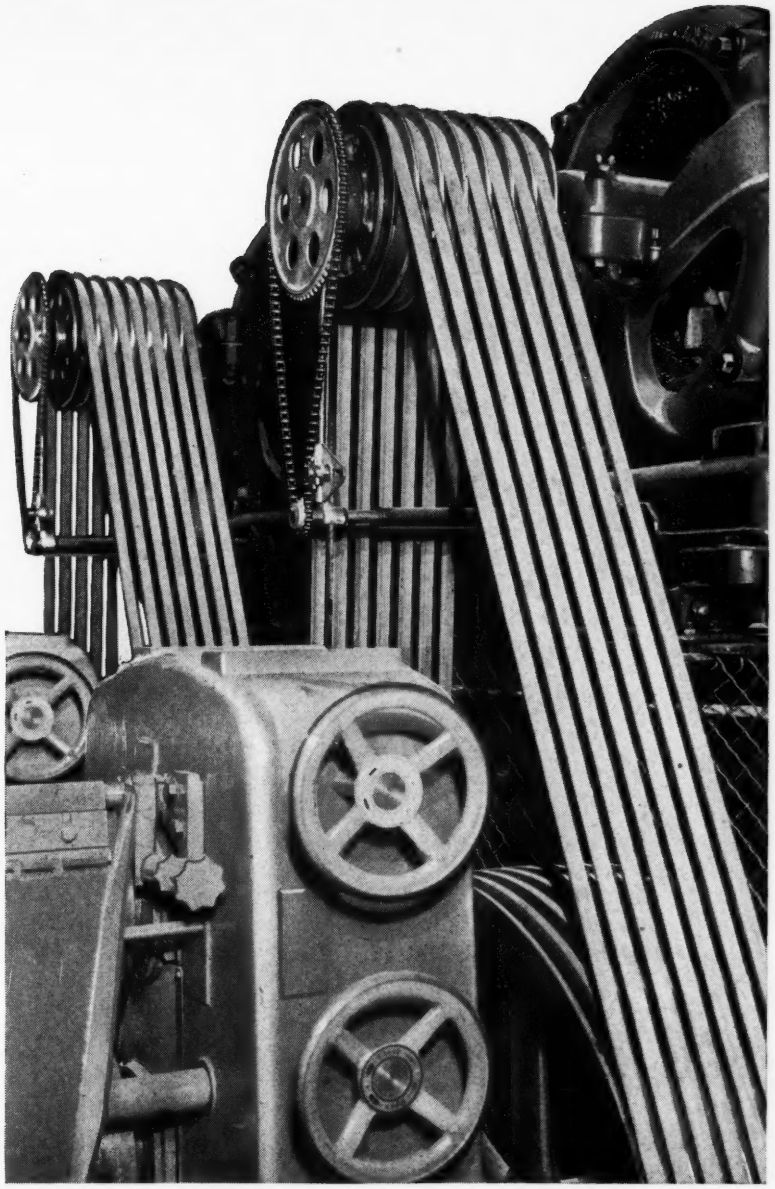
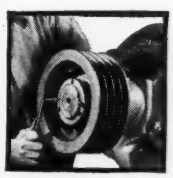


(ABOVE) TEXROPE Vari-Pitch sheaves for motion control. They give smooth speed variations up to 25% on these roller mills used in the manufacture of soap chips. Changes in speed are made without stopping the machines.



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Here is the standard heavy-duty sheave for fast, easy mounting and demounting. *Sheave comes completely assembled.* Simply slip it on the shaft, move it to exact alignment, and tighten three cap screws. It's locked on the shaft with the grip of a vise — yet can be removed just as easily. No hammering, filing or reaming. No set screws to damage shaft. A2103

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YARWAY STRAINERS

Belt Co.; J. M. McClintock, Illinois Iron & Bolt Co.; Howard E. Sill, Muncie Gear Works, Inc.; J. H. Simpson, Hershey Machine & Foundry Co.; and Milton A. Young, Catskill Metal Works. Walter Sormane is chairman of the board. Membership of the standing committees will be named shortly by President Sormane.

AIRCRAFT GAS TURBINE DEVELOPMENT

One of the largest government-sponsored aircraft gas turbine experimental projects in the country was identified today with the De Laval Steam Turbine Company of Trenton, N. J.

H. L. Watson, De Laval president, formally announced completion of plans for the project, which is being carried out exclusively by the recently organized De Laval Aircraft Gas Turbine Division.

While details of the new aircraft gas turbine could not be made public it was disclosed, however, that the project involves, among other features, a new and unusual concept of compressor and gas turbine design.

ALLIS-CHALMERS' TESTING FACILITIES

Improved testing and laboratory facilities for a variety of its industrial and marine products have been announced in recent months by the Allis-Chalmers Mfg. Co., Milwaukee, Wis. Among these are a new "shock-test" laboratory developed in cooperation with the Navy during the war, a new electronic processing laboratory and a new steam turbine auxiliary test floor.

The "shock-test" laboratory is available to the company's engineering staffs for testing materials and devices likely to be subjected to extremely harsh treatment in service. It is equipped to handle high-impact shock, vibrating, humidity and temperature, salt spray, and electrical and mechanical life tests. The shock tests consist of subjecting the product to different mounting positions in a special high impact shock machine capable of handling devices up to 4500 pounds and having a shock blow capacity of 18,000 ft-lbs. By giving the shock in various directions, subsequent visual inspection and operating devices provide positive evidence of the strength of the product being tested.

The new electronic processing laboratory in Allis-Chalmers' electric control plant is devoted exclusively to the analysis and processing of samples and the design of proper coils for production work for present and prospective users of the company's induction heating equipment. Equipped with standard Allis-Chalmers heating units, the laboratory also provides improved facilities for those wishing to visit the plant to observe tests on their own products.

Hagan Corp. reported recently that it had acquired the Willburt Co's. Plant No. 1 at Orrville, O., in which all Hagan equipment has been manufactured for 27 years, and will begin at once an expansion program to meet increased demands.

New Gasket Materials! *Better Answers to New Product Problems;* Old Ones, Too!

FACILITIES
ABILITIES
PRODUCTS
THAT'S FEL-PRO!
SUPERIOR PACKINGS . . . New properties! New constructions! In these advanced packings, mineral and vegetable materials, and various synthetic plastic preparations, are woven, combined and formed — or are sheathed with, or combined with different metal foils — to set new performance standards in handling conditions imposed by extreme temperatures, compression, acid, oil, caustic, etc. Ask about these successful new packings!

New Abilities in Materials Provide New Possibilities in Design, Performance

Consult Fel-Pro! Engineers who are working on new products or redesigning old ones find many of their gasket, packing and sealing wants anticipated here at Fel-Pro. Here, new processing has greatly widened the usefulness of many conventional materials, and new synthetics with new characteristics are answering new problems and better answering old problems.

Suppose, for example, that you wanted new mechanical properties in a dielectric material, or an oil-resisting gasket that retained a certain, measurable resilience despite new heat conditions, or a packing that remained indifferent to acid under a new set of circumstances: Ask Fel-Pro. If it isn't already here, we will develop it here for you! So, either way, whether you seek something you didn't think existed before, or want to do an everyday job better, it should pay you to write and see if Fel-Pro can satisfy your want. . . . FELT PRODUCTS MFG. CO., 1511 Carroll Ave., Chicago 7, Illinois.

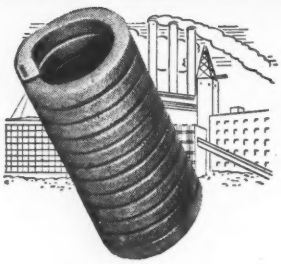
FEL-PRO*tect* *with*

1844

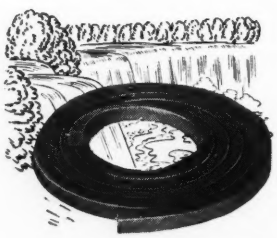
Sealing Materials, Gaskets, Packings, Sound- and Vibration-Dampening Materials, Specially Treated, Die-Cut and Fabricated by Fel-Pro.

3 PLACES for a BETTER PACKING

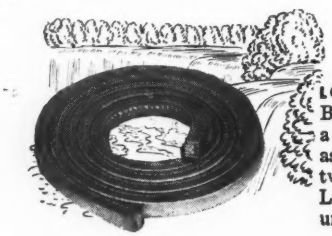
For each of these services Belmont has created a packing with extra construction features that provide more certain sealing and longer life. And for *any* service—steam, water, oil, gas, air, acids, alkalis, ammonia—your Belmont distributor has the *right* packing.



HIGH PRESSURE STEAM RODS—Belmont's No. 30 Asbestos Packing has a unique center construction for greater resiliency and flexibility, extra takeup on the gland as the packing wears, extra "edge wear". The center block is pleated on itself, accordion-fashion, at approx. 90° with the rod.



LOW AND INTERMEDIATE STEAM RODS (also hot and cold water rods and plungers)—Belmont's No. 419 Rubber-and-Duck Packing has a hollow center which provides a point of least resistance for expansion and contraction. Friction is minimum, because the packing "breathes" toward the hole.



LOW PRESSURE TO HEAVY DUTY WATER—Belmont's No. 9 Special Hydraulic Packing has a rubber-and-duck channel which not only acts as a wiper but also protects the flax—actually two packings in one against the wearing surface. Linen thread stitching prevents displacement under gland pressure.

THERE IS A BELMONT PACKING FOR EVERY SERVICE

Belmont distributors are located in every large industrial center, ready to give you prompt delivery from local stocks.

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

IN THE BLUE-AND-ORANGE BOX

6 New Folders
Write us for new folders on Belmont Centrifugal and Rotary Pump Packings, Flax Packings, Hollow Center Packings, Oil and Gasoline Packings, Rod Packings, Sheet Packings.

THE BELMONT PACKING AND RUBBER CO.
Butler and Sepviva Streets
Philadelphia 37, Pa.

HEWITT MOVES PHILADELPHIA OFFICE

Hewitt Rubber of Buffalo, division of Hewitt-Robins, Inc., has announced the moving of its Philadelphia district office and warehouse from 20 South 15th Street to 401 North Broad Street.

The new location is under the supervision of C. F. Holden and Jack T. Sheldon.

MANUFACTURERS' *Personals*

NEW HEAD FOR U.S. STEEL SUPPLY

Leadership in the United States Steel Supply Co., a U. S. Steel subsidiary, changed recently when Leslie B. Worthington, formerly sales vice president, was elected president and Ernest E. Aldous retired from the presidency in accordance with the corporation's retirement policy. The company, which maintains general headquarters in Chicago, operates warehouses in Baltimore, Boston, Cleveland, Newark, Pittsburgh, St. Louis and St. Paul as well as in Chicago.

COX PRESIDENT OF CARNEGIE-ILLINOIS

Charles R. Cox has been elected president of Carnegie-Illinois Steel Corp., succeeding John Lester Perry, who has become assistant to president, United States Steel Corp., of Delaware.

Mr. Cox has been president of National Tube Company, another U. S. Steel subsidiary, since March, 1943. Joining the National Tube Company as general superintendent, Ellwood works, in 1934, Mr. Cox's rise in that company was rapid. In 1936 he was made vice-president in charge of operations; in 1941, executive vice-president; and 1943, was elected president of National Tube.

FLANNERY JOINS HENDY IRON WORKS

Charles A. Flannery, former Colonel, Corps of Engineers, has joined the Joshua Hendy Iron Works, Sunnyvale and Torrance, California, as Manager of General Products Sales, according to announcement made recently.

Mr. Flannery, prior to the war, was sales manager of plate fabrication for Consolidated Steel Corp. and vice president and West Coast manager of Industrial Engineering Co. He has been identified with sales and engineering work continuously since graduation from the University of Illinois in 1917.

DOWELL ANNOUNCES CHANGES

Dowell Inc., subsidiary of The Dow Chemical Company, has announced some changes in the Dowell sales staff.

H. W. Ross, formerly Assistant Sales Manager, assumes the duties of Sales Manager in charge of the

COMBUSTION EFFICIENCY

Correct Fuel Distribution in Firebox Cuts Boiler's Coal Need 15%

PATENTED, PRECISION INSTRUMENT INSTANTLY ANALYZES COMBUSTION GASES

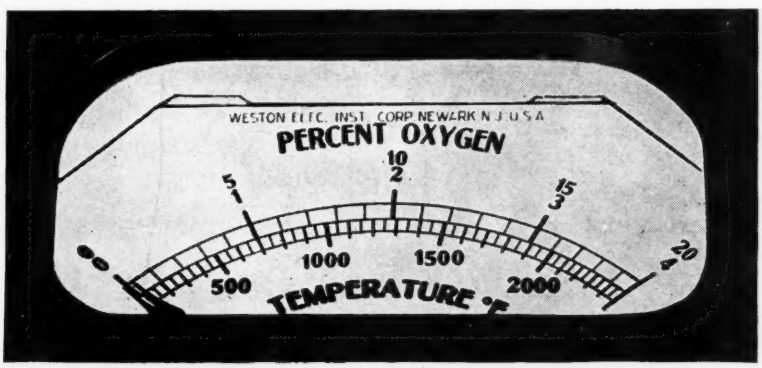
Lubrication Engineer's Report

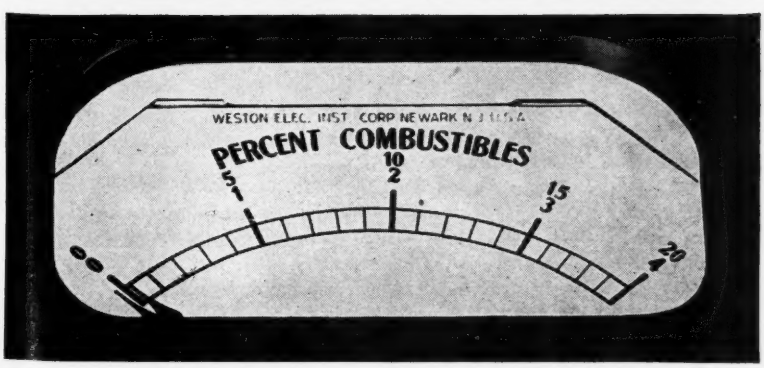
"A check on a boiler in a customer's* plant at Niles, Michigan, demonstrated how the Cities Service Heat Prover shows the fuel saving possible when the boiler is operating efficiently.

"On most under-feed stokers, there is greater depth of burning coal over the retort—leaving the sides and end of the grates with a thin layer of coal. This thin layer of hot coal soon burns through in spots leaving holes in the fire so that the grates are not covered entirely with coal. These bare spots on the grates allow the air to circulate through the firebox without coming in contact with the burning coal, thus increasing the stack temperature with attendant loss of combustion efficiency.

Grates Evenly Covered

"At intervals of thirty minutes, we took a poker, pushed the hot coal from the center, covering the holes and edges of the firebox with coal so that every part of the grates was covered. This registered highest efficiency on the Heat Prover dials.





These dials on the compact portable Heat Prover instantly register an analysis of flue gases.

"This boiler was using 18,000 pounds of coal a day and by covering the holes in the fire every thirty minutes, daily consumption was reduced 3,000 pounds a day or a saving of about 15% to 17%."

Fuel Cut 3000 lbs. Daily

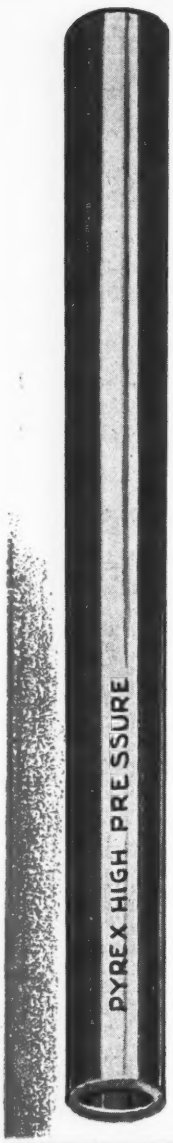
The Heat Prover is a portable combustion gas analyzer patented by Cities Service and operated by trained Cities Service engineers. It is used to check efficiency of every type of fuel combustion equipment. For information call your nearest Cities Service branch office, (Arkansas Fuel Oil Co., in the South); or write to Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

Heat Prover Service Available

**Name on request.*

CITIES SERVICE OILS
ONCE-ALWAYS

FOR EVERY LUBRICATION PROBLEM CALL Cities Service FIRST!



Gauge Glasses

TESTED

for Temperature Shock

Heated to a temperature of 425°F and then plunged into ice water creates several times the thermal shock that any gauge glass is called upon to withstand. Yet that is a routine test for Pyrex Gauge Glasses. That is only one of the reasons why they stand up under actual service conditions.

Machine drawn accuracy that permits easy installation and reduces to a minimum installation strains that cause breakage, remarkable resistance to the solvent action of hot water or steam, a hard smooth surface that resists abrasion and scratching—are other factors which make Pyrex Gauge Glasses the most economical glass you ever used. Corning Glass Works, Corning, N. Y.

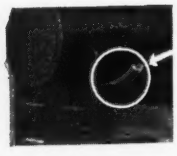
"PYREX" and "CORNING" are registered trade-marks and indicate manufacture of Corning Glass Works, Corning, N. Y.

CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

"Boiler Repairs Reduced 75%"

writes user of NATIONAL GIRTH SEAM PROTECTOR



We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.

Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 928-29 REIBOLD BLDG., DAYTON, OHIO

Industrial Division which is primarily concerned with the removal of various types of scale and sludges from all types of industrial heat exchange equipment. Mr. Ross will however continue to maintain certain activities in the Petroleum Division.

M. L. Stirling, formerly Assistant Sales Manager, becomes Sales Manager of the Petroleum Division and will direct sales of Dowell's oil field services including oil and gas well acidizing, plastics, water locating, electric pilot and cementing services that are so widely used in well completion and work over operations.

Guy Williams, who has been attached to Dowell's sales department for many years will become Assistant Sales Manager in charge of Product Sales including Dowell Paraffin Solvent, Jelflake and Jelfoam. He will also be active in general sales promotion in both the Industrial and Petroleum Divisions.

FORT AWARDED ORDER OF MERIT

The Order of Merit, highest honor conferred upon its employes by the Westinghouse Electric Corp., has been presented to Tomlinson Fort, manager of Central Station Department, for distinguished service to the electrical industry.

The award, which is accompanied by a citation and a bronze medallion inscribed with a silver "W", was granted Mr. Fort for "his successful efforts in building Westinghouse position in the public utility industry; for his constructive help in developing programs to increase the use of electrical power; and for his willing cooperation with others, both within and outside the Company."

ATHERTON HEADS SPRINGFIELD BOILER

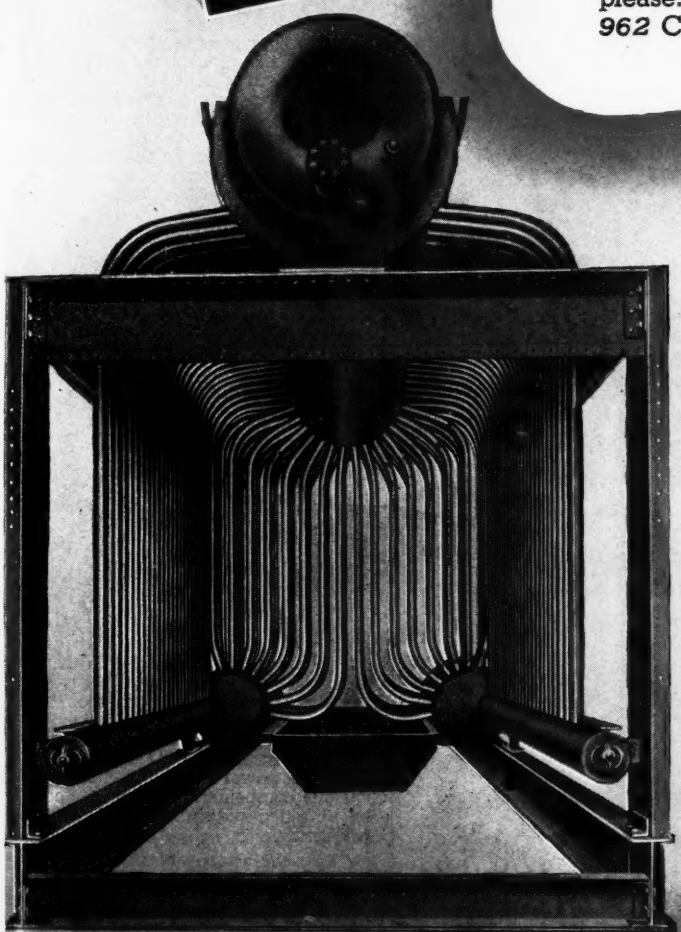
Springfield Boiler Co., Springfield, Ill., announces the election of George R. Atherton as President to succeed Owsley M. Brown, of Springfield, who has retired. Mr. Atherton is widely known in the heating and air conditioning industry through a long connection with the American Radiator—Standard Sanitary sales organization. Other officers announced by the company in the reorganization are Ross Irwin, Vice President and Chief Engineer; John Pratt, Secretary and Assistant Treasurer; and C. G. Smith, Assistant Secretary; all long-time executives of the company.

E. D. Benton, formerly fuels engineer with the Louisville and Nashville Railroad, has been named to the staff of Battelle Institute, Columbus, Ohio, where he will be engaged in research on the utilization of fuel in locomotives.

R. W. Mason, Jr., formerly associated with The Lithium Company, Newark, N. J., has joined the Development and Research Div. of The International Nickel Co. Inc. He will make his headquarters at the Detroit Technical Section of the Division on the fifth floor (5-223) of the General Motors Building, Detroit, Mich. He will serve in the Detroit office as metallurgist and consultant to consumers and producers on the use of nickel in ferrous and non-ferrous castings.

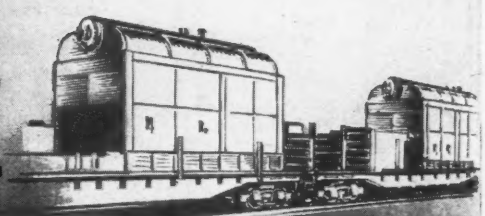
UNION OFFERS *New* BOOKLET ON *New* BOILER DESIGN

We have prepared a book illustrating the construction of our latest boiler development, the "S" type boiler. Complete engineering data is included. Request your copy of this booklet on company letterhead, please. Address Union Iron Works, 962 Cascade St., Erie, Pa.



The UNION "S" type boiler is a compact self-contained unit complete with water cooled furnace. It can be shipped fully assembled in sizes to 300 H. P. It has narrow overall width and large furnace volume in a low setting height, providing large capacity in limited space.

You will be interested in knowing how we have designed water wall circulation without circulator connections and in many other new features.

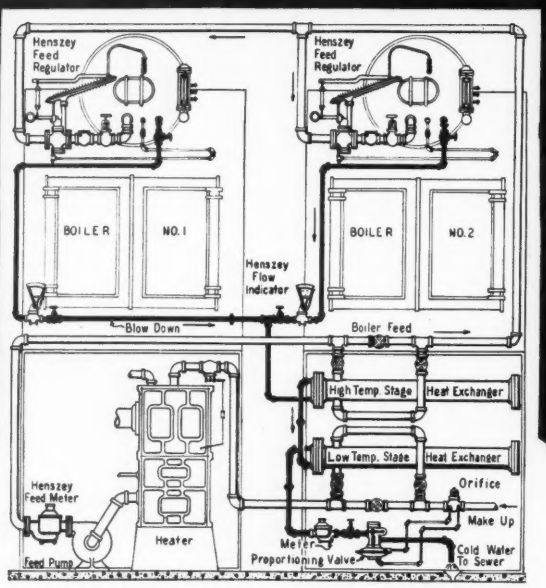


UNION IRON WORKS • ERIE, PA.

Since 1890

BOILERS — PROCESS EQUIPMENT — FABRICATED STEEL

HENSZEY Continuous Blowdown

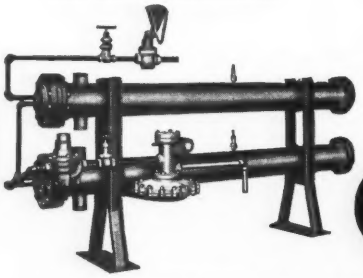


Provides Controlled

BOILER WATER CONCENTRATION

A Henszey Continuous Blowdown System will keep boiler water concentrations within safe margins — preventing foaming, priming, and the formation of sludge and scale (with proper chemical treatment). This absolute control of boiler water concentration is accomplished continuously, automatically, and without heat loss.

Check the advantages of Clean Steam and Low Cost Power in your plant — present or planned — then call Henszey for practical recommendations.



Contact your nearest Henszey representative or write to

HENSZEY COMPANY
Department C9
WATERTOWN • WISCONSIN

HENSZEY

CONTINUOUS BLOWDOWN *and* BOILER PLANT SPECIALTIES

Boiler Feed Regulators • Distillation Systems • Heat Exchangers
Feed Water Meters • Flow Indicators • Proportioning Valves
also MILK EVAPORATORS and PREHEATERS

Appointment of Walter C. Kerrigan as Manager of the Nickel Sales Dept. of The International Nickel Co., Inc., to succeed the late Rudolph L. Suhl, has been announced. Mr. Kerrigan has been associated with business in metals and ores since 1919. He joined International Nickel in 1930 and has been an Assistant Manager of its Nickel Sales Department since January, 1933.

Walker L. Cisler, chief engineer of power plants of Detroit Edison, left by plane for Paris, France, on June 24, to attend the first post-war congress of "CIGRE", as it is known throughout the electrical world. This is an international conference on high voltage electric systems and equipment which is meeting for the first time since before the war. Some 100 technical papers are being presented. He will also attend the meeting of the Public Utilities Panel of the Emergency Economic Committee for Europe which he helped to organize.

Republic Flow Meters Co. announces the appointment of Frederick H. Meyers as manager of its Cincinnati district which includes Central and Southern Ohio and Eastern Kentucky.

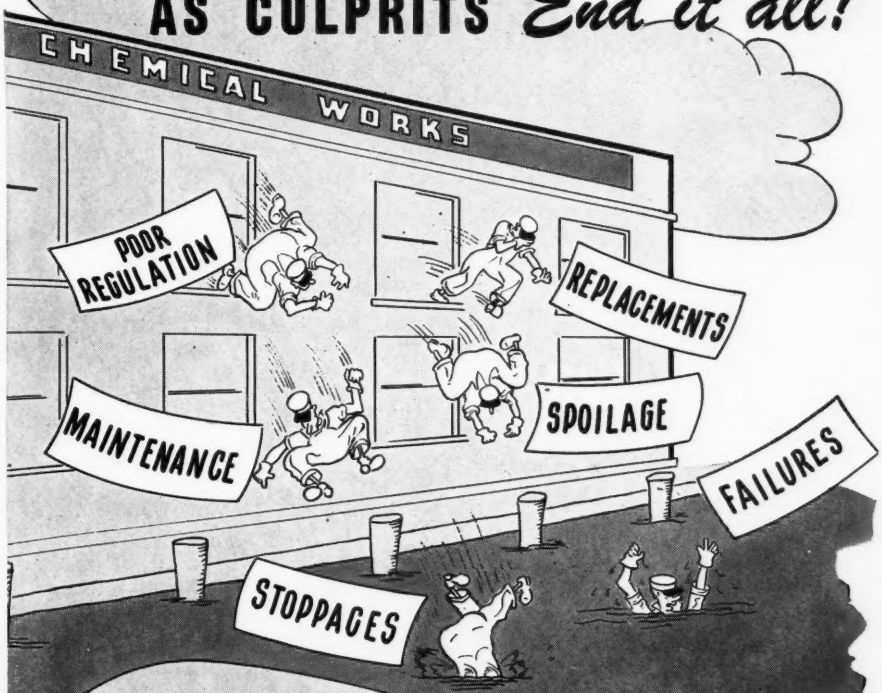
Mr. Meyers received his technical education at Pratt Institute and Polytechnic Institute of Brooklyn, and is a registered professional engineer. For seventeen years prior to joining Republic Flow Meters Co. he was engaged in test work for a large eastern public utility.

Charles F. Kottcamp, until recently Lieutenant Commander, USNR, has joined the staff of Locomotive Development of Bituminous Coal Research, Inc., Baltimore, Md. He has been appointed assistant to Director of Research John I. Yellott, who is heading the Committee's project for developing and building a coal-fired gas turbine locomotive. While on active service in the Navy, Mr. Kottcamp did much work in turbine testing and was directly in charge of the testing of the 3500-hp, 1500-F, U. S. Navy Experimental Gas Turbine Plant at the U. S. Naval Engineering Experiment Station, Annapolis, Md., as described in POWER PLANT ENGINEERING, May, 1946, pages 86 to 89. Included in that report is a statement by Mr. Kottcamp on the testing procedures used in the plant. It emphasizes especially the way in which instrumentation was developed to determine various operating factors within extremely close range of accuracy, so that the efficiencies and power requirements of the various components of the unit could be obtained within plus or minus 1 per cent.

The appointment of G. R. LaWall as quality control engineer in the Wiring Device and Accessory Equipment Division General Electric, has been announced. Beginning his association with General Electric in 1919 at Nela Park, Cleveland, Mr. LaWall left the engineering department in 1924 for a position in the sales promotion department but returned to engineering in 1931. He also served in the specialty appliance department at Nela Park and on the Cleveland office sales promotion force before coming to Bridgeport in 1939 for display design work.

CRIME WAVE OVER

AS CULPRITS *End it all!*



Here's what caused it

CASH STANDARD *Streamlined* TYPE 1000 PRESSURE **REDUCING VALVE**

GOOD REASON why these culprits took a quick nose dive into the "drink." It was their only out. When the CASH STANDARD Streamlined type 1000 Pressure Reducing Valve was installed, their activities came to an abrupt end.

You too can rid your plant of such daily plagues as high costs and operating troubles due to poor valve performance.

Simply put it up to the CASH STANDARD "TYPE 1000" —find out in detail about the streamlined design—the construction—the performance that works so completely in your favor Send for Bulletin "962."

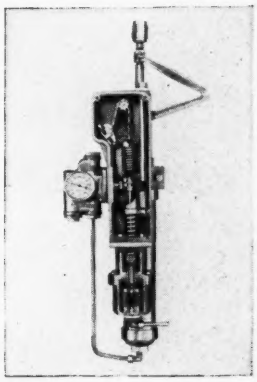
Maximum Capacity When Needed Most • Accurate Pressure Control Under Toughest Working Conditions • Trouble-Free Service • Smooth Operation • Tight Closure • Accurate Regulation • Speedier Production Results • Elimination of Failures • Constant Delivery Pressure • Cost Saving Operation • No Spoilage • Practically Zero in Maintenance Costs.

CASH STANDARD CONTROLS.. VALVES

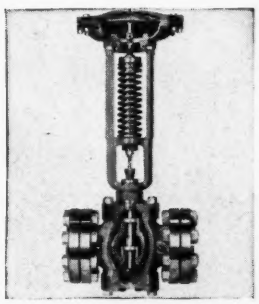
A. W. CASH COMPANY
DECATUR, ILLINOIS

BULLETINS AVAILABLE ON OTHER CASH STANDARD VALVES

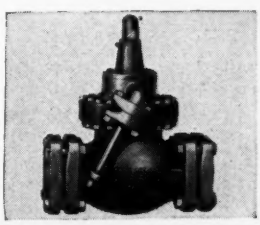
Send for them



Bulletin 963 features the CASH STANDARD Type 100 Series of Super-Sensitive Controllers — various types for automatically operating valves, dampers, rheostats, stokers, pulverizers, fans, and other apparatus. 16 pages filled with descriptions and applications.



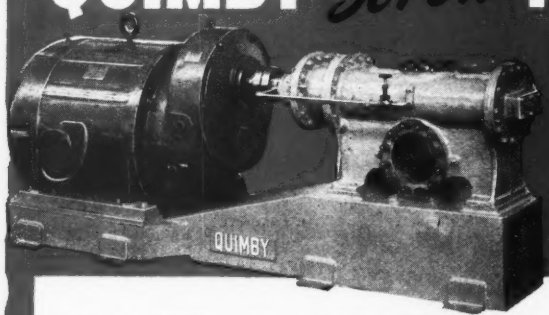
Bulletin 968 features the CASH STANDARD Type 34 Pressure Reducing Valve — direct operated — direct acting for handling steam, hot water, cold water, air, oil, brine—and most liquids and gases except some injurious chemicals. Illustrates and describes the different styles available and tells about their applications. Three pages of capacity charts.



Bulletin 956 features the CASH STANDARD Type 4030 Back Pressure Valve — designed to automatically maintain a constant pressure in the evaporator corresponding to a constant temperature desired. Shows an Ammonia and Freon Gas Capacity Chart based on ABSOLUTE pressures.

There is no Substitute for a

QUIMBY *Screw* PUMP



No. 6 Gear-in-Head Screw Pump for fuel oil booster and transfer service.

Only in a QUIMBY can you get *all* of these outstanding features: full herringbone gears, new non-slip screw design, full-floating shafts, and the new "FLOATING LINK," an exclusive Quimby device. Besides, the QUIMBY is the only screw pump 100% anti-friction-bearing equipped. When you buy a QUIMBY Screw, Rotex, or Centrifugal Pump, you are benefitting by the results of 52 years of pump-designing experience!

QUIMBY PUMPS
The KNOW-HOW of Pumping Since 1894

H. K. PORTER COMPANY, Inc.
PITTSBURGH 22, PENNSYLVANIA
Quimby Pump Division
NEWARK 5, N. J.
District Offices in Principal Cities

Who Else
WANTS TO TRIM 1/3 FROM MAINTENANCE COSTS?

OUR specialized know-how in simplifying power plant maintenance problems has helped reduce maintenance worries, trimmed maintenance expenses as much as ⅓ for many clients.

Bryan maintenance surveys and recommendations—backed by 20 years of successful maintenance, consulting and engineering work—cover:

STEAM & WATER	REFRIGERATION
ELECTRICITY	AIR CONDITIONING
ELEVATORS	FIRE PREVENTION

We will instruct your men in modern money-saving maintenance methods, city ordinances, state laws and national procedures. No maintenance problem is too large or small for our staff. Industrial Plants, Office and Loft Buildings, Hospitals, Movie Studios and Theaters have been our specialty.

It will pay you to write us about maintenance studies and recommendations for your plant or building

JOHN S. BRYAN, M.E.
Maintenance Consulting & Engineering
341 So. Columbia Ave. Los Angeles 13, Calif.

LaMOTTE BOILER FEED WATER TEST UNITS

The LaMotte Research Department has developed a reliable series of chemical tests for boiler feed water control of the following constituents:

Phosphates	Dissolved Oxygen
Chlorides	Sulfates
Total Alkalinity	Hardness
pH (Hydrogen-ion Concentration)	

For positive control of efficient water treatment, there is a LaMotte Unit for each constituent (Phosphate Comparator, illustrated and described below). Each unit is simple to operate and inexpensive to install. Write for illustrated booklet describing this equipment.

LaMotte Phosphate Comparator

For control of phosphate treatment of boiler feed water. A rapid, simple and accurate method. The new LaMotte Comparator covers phosphate concentrations from 0 to 100 p.p.m. Can also be used for polyphosphates. Outfit comes complete with instructions.

Price $15.00 f.o.b. Towson.

LaMOTTE CHEMICAL PRODUCTS CO.
Dept. P. P. E., Towson 4, Baltimore, Md.

The Graver Tank & Mfg. Co., Inc., East Chicago, Ind., recently announced the appointment of Edward W. Welp to the position of Sales Manager of water conditioning equipment. Mr. Welp, former technical director of Graver's process equipment division, has spent 32 years with the firm in every phase of research, design and construction of water conditioning equipment.

J. H. Swan of Klipfel Manufacturing Co., Chicago, and R. H. Thomas, President of Economy Pumps, Inc., Hamilton, Ohio, have announced the purchase of the Klipfel stock by Economy. Mr. Swan remains with the Company in an advisory capacity, and as Chairman of the Board of Klipfel.

Fairbanks, Morse & Co., has announced the retirement of A. E. Ashcraft who has for many years been Vice President in Charge of Manufacturing. Mr. Ashcraft continues to be a director of the company. C. H. Morse, III, Vice President, has been placed in charge of all manufacturing plants and operations. Henry M. Haase has been appointed Manager of the Beloit, Wisconsin, Works of the company following the resignation of A. C. Howard.

Theodore A. Dyke has been appointed manager of the Export Division of Combustion Engineering Co., Inc., New York. He succeeds the late J. B. Crane. Mr. Dyke, with a background of chemical engineering and business administration, joined Combustion Engineering Company in 1936. For more than a year during the war his services were loaned to the U. S. Government as Chief of the Industrial Equipment Group in the Requirement Division, Office of Lend-Lease Administration, under Mr. Stettinius. Over the past ten years he has been closely identified with the numerous foreign contracts of his company, particularly those pertaining to Latin American countries in which he has traveled extensively.

Crosby Steam Gage and Valve Co., Boston, Mass., announces that William P. Husband, Jr. has been elected President and Treasurer. Mr. Husband is also President and Treasurer of the Ashton Valve Company of Cambridge, Mass.

J. W. Weingartner has been made production control manager of the Brown Instrument Company, Philadelphia, it was announced recently. Mr. Weingartner has been with this industrial division of Minneapolis-Honeywell Regulator Co. for the past 22 years. He will also direct purchasing. Charles Goodman has taken over the duties of purchasing agent under Mr. Weingartner's supervision and William Lawson has been named assistant production control manager.

Ralph P. Wagner, Commercial Manager of the New York Power and Light Corporation, Albany, New York, has been elected Chairman of the Commercial Division General Committee of the Edison Electric Institute. In his new post, Mr. Wagner will supervise the activities of 22 commercial committees of the electric utility trade association, which are now engaged in load-building activities in all phases of utility promotional work.

This *one* basic blueprint* solves *all* problems in coal-and-ash-handling

Here's a *complete* plan for a system that will take care of your coal-and-ash-handling problems, whether your plant is large or small. This *typical*, basic G-W System can be adapted, with but slight modifications, to any plant's requirements.

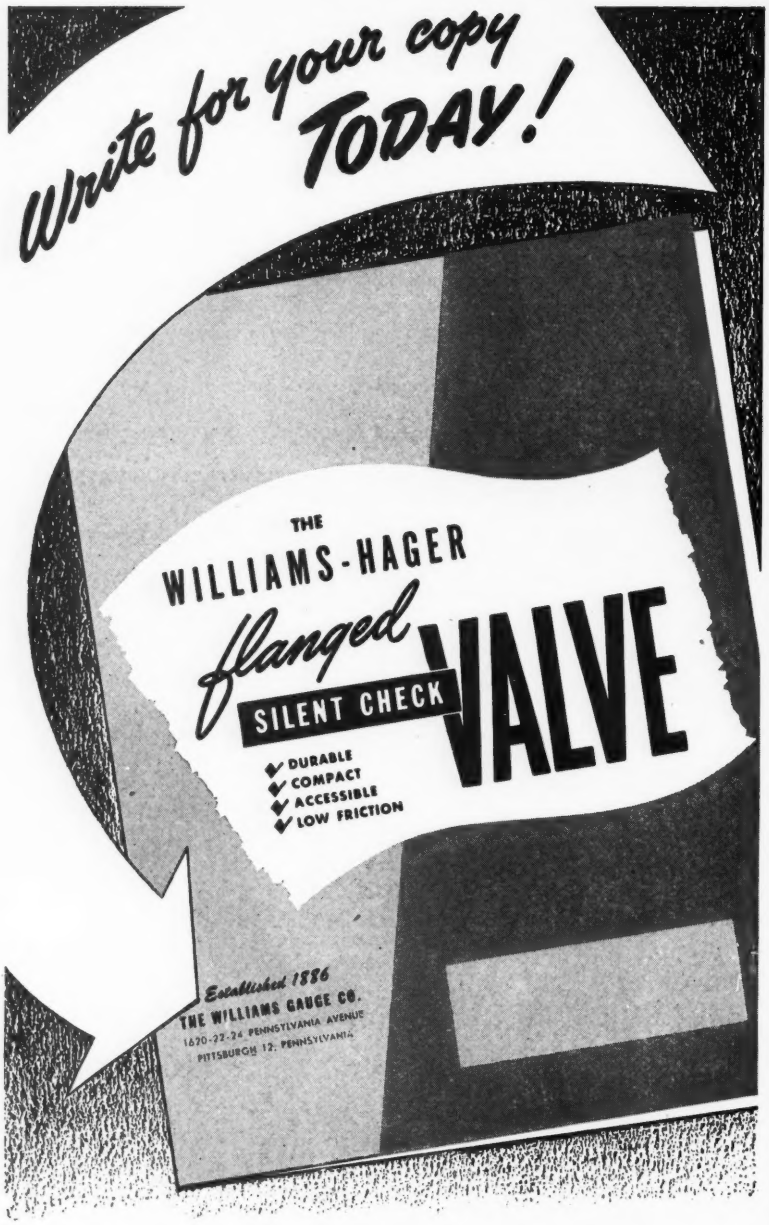
*G-W SYSTEM NOW BEING BUILT FOR A 2,000 kw. UNIT POWER PLANT

COAL IN . . .
ASHES OUT

1. Coal passes through *Grating, Hopper* and *Control Gate* to feeder pans.
2. *Apron Feeder* draws coal from hopper, conveys it at uniform rate to crusher.
3. *Crusher* delivers stoker-sized coal to elevator boot.
4. *Bucket Elevator* discharges coal to surge hopper.
5. *Surge Hopper Control Unit* assures constant supply to scale.
6. *Scale* automatically weighs, records and discharges to shuttle belt conveyor.
7. *Shuttle Belt Conveyor* serves several bins from central weighing point.
8. *Storage Bins* have coal level control.
9. *Control Gate* and *Spout* to stoker.
10. *Ash Unloading Gate.*
11. *Ash Cart* manually operated through tunnel.
12. *Ash Cart* electrically operated for ash disposal.

G-W HANDLES IT . . .
faster • easier • cheaper

SINCE 1814



HAS "WATER HAMMER" BEEN A PROBLEM IN YOUR PLANT? This new bulletin completely describes the Williams-Hager Flanged Silent Check Valve—designed to meet this problem and one of the most important developments in Check Valve design. Thoroughly tested in every industry, for every type of service—with many installations serving trouble-free for upwards of 18 years.

THE WILLIAMS *Gauge* COMPANY

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New ENGINEERING BOOKS

Alemite Answers. Copyright 1945; 223 pages; 8½ by 8¾ in.; cloth board binding; prepared and published by Alemite Division, Stewart-Warner Corp., Chicago 14, Illinois. Price $3.00.

This book owes its origin and much of its contents to Alemite's experiences in preparing lubrication training material for the Armed Services during the war period. The company executives explain that the available material, highly technical in nature, had to be interpreted and imparted to non-technical audiences via training films and demonstrations in minimum time. The types of illustrations employed successfully in this work thus predominate in this new history and exposition of lubrication, although technical accuracy and scientific foundation are not slighted or abused by this method of presentation. In the foreword it is stated that it is Alemite's intention to concentrate its resources on the task of expanding the non-technical man's understanding of how to buy intelligently and correctly apply petroleum lubricants. The statement is also made that the era has passed when rule of thumb procedures govern lubrication practice. Lubrication is a science founded upon logical analyses, guided by research and tempered by experience. Progress is dependent upon a continuous exchange of ideas and this book is designed to contribute to this exchange by translating consumer's questions into manufacturer's answers. The book is a well-told story of lubrication and lubricants and is not only interesting reading but contains a wealth of information which every lubrication engineer will appreciate.

Electronic Equipment and Accessories, by R. C. Walker; First Edition; 393 pages; illustrated; size 5¾ by 8¾ inches; cloth; published by the Chemical Publishing Co., Inc., 26 Court St., Brooklyn, N. Y.; 1945. Price $6.00.

The object of this book is to present a simple introduction of the main sections of the subject of electronics to practical engineers, mechanics, students and other readers who at least have acquired the elements of electricity and magnetism but who are not specialists in the use or design of electronic equipment. The aim throughout has been to adhere to principles and to quote applications outside the field of telecommunication as illustrative examples, rather than to attempt a collection of as many known industrial uses as possible. Every electrical engineer and mechanic who wishes to keep in touch with modern progress will find this book well worth adding to his technical library.

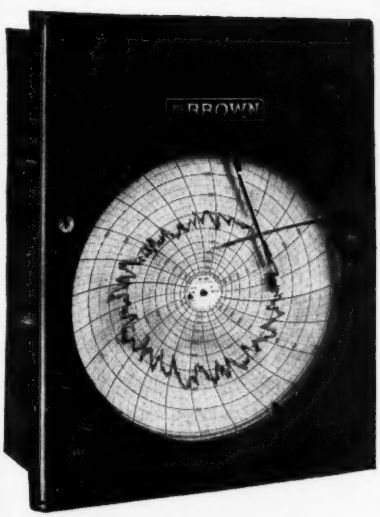
Electronics Dictionary, by Nelson M. Cooke and John Markus, First Edition, 433 pages, 5¾ by 8¾ inches, over 600 illustrations, cloth, published by the McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, N. Y., 1945. Price $5.00.

This book is an up-to-date, well il-

How Many Fuel Dollars

Are You WASTING?

You Can Get the Answer with BROWN FLOW METERS



Brown Electric Recording Integrating Flow Meter

While other production materials and facilities are carefully computed, in many plants steam—an expensive production tool—is freely used and often wasted, without accounting.

Present day accounting methods call for accurate maesurement of the steam used in each department so that costs can be properly allocated. Permanent records of departmental steam consumption are a real incentive to eliminate wasteful usage.

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Brown Flow Meter dual chart records show both rate and total flow—an exclusive Brown feature.

Write for catalogs 2008 and 2204-2. THE BROWN INSTRUMENT COMPANY, a division of Minneapolis-Honeywell Regulator Co., 4491 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada; London, England; Stockholm, Sweden; Amsterdam, Holland.

BROWN FLOW METERS

. . . MINNEAPOLIS - HONEYWELL CONTROL SYSTEMS . . .

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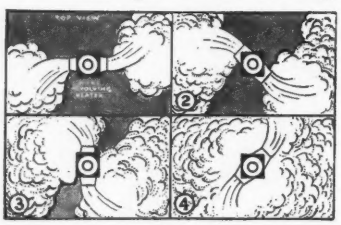
Revolving Unit Heaters Insure Complete, Thorough Coverage Regardless of Obstructions [in industrial plants as in airplane hangars]

Not just another unit heater, the WING REVOLVING HEATER is unique in that it does what no other heater can do—its slowly revolving outlets gently distribute the heat continuously in a constantly changing direction. It reaches over, around and under obstructions into out-of-the-way corners, its moving streams of heated air quickly warm up a plant in the morning.

ADVANTAGES OF WING REVOLVING UNIT HEATERS

1. **Makes workers feel comfortable, live and invigorated—more productive.**
2. **Reaches over and around obstructions and into out-of-the-way corners.**
3. **Moving discharge heats up plant quickly on cold mornings.**
4. **Reduces absenteeism due to colds resulting from drafts, chills or overheating.**
5. **Is an excellent cooling system in summer with steam off and fans on.**

Revolving Discharge Outlets for Thorough Heat Coverage



1. Heater starts. 2. 15 seconds later, 45° revolution. 3. 30 seconds later, 90°. 4. 45 seconds later, 135° revolution.

Wing Revolving Unit Heaters keep the heated air moving, circulating around obstacles, seeking out far corners, spreading an even, uniform, healthfully invigorating blanket of warm air over the entire working area.

Its properly warmed, healthful air currents thoroughly distributed, create a sensation of live, invigorating comfort for the workers. Wing Revolving Unit Heaters are used in many of the country's leading industrial plants. Write for a list of installations.

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Wing REVOLVING UNIT HEATERS

lustrated dictionary containing clear cuts and accurate definitions of nearly 6500 terms used in radio, television, industrial electronics, communications, facsimile, sound recording, etc. This compilation of authoritative, readily understood definitions, constitutes the most comprehensive dictionary of its type available. There are more than 600 appropriate diagrams and sketches to illustrate the principles and equipment described.

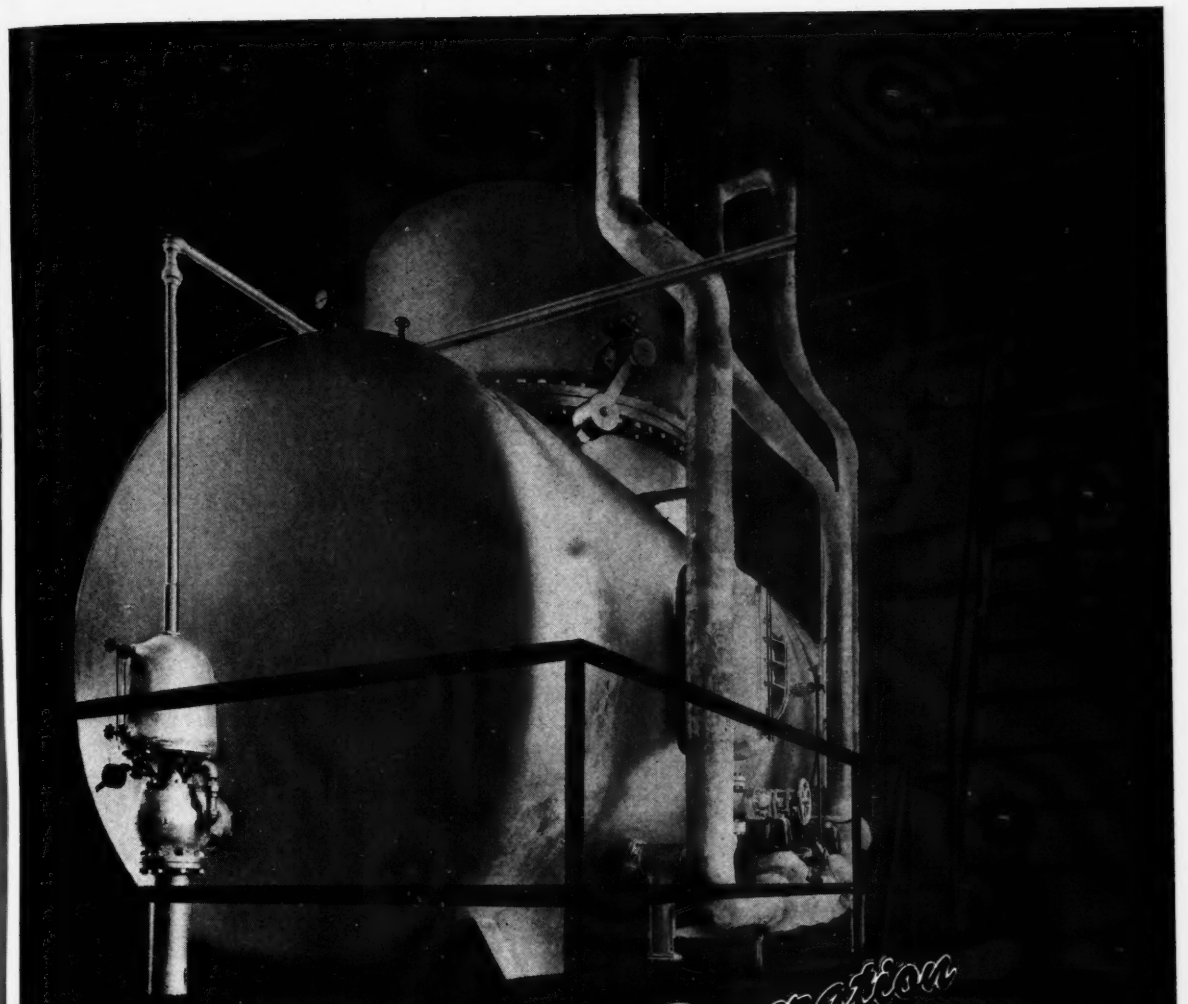
The goal of the authors was to present the language of electronics in such a manner that the definitions would be of value to those who need an electronics dictionary—the engineers who must develop applications for electronics equipment, those who must use and maintain such equipment, and particularly the beginners who are interested in learning about electronics.

Although the book is written primarily at the level of a student who is learning fundamental electronic principles, every effort has been made to define the terms with accuracy and carefulness demanded by the engineer. At the same time, most of the definitions will have useful meanings to non-technical readers because each definition has been made as complete as possible in a technical work of this nature. Nelson M. Cooke is a Lieutenant Commander in the U. S. Navy and is Executive Officer, Radio Matériel School, Naval Research Laboratory, Washington, D. C. John Markus is Associate Editor of Electronics.

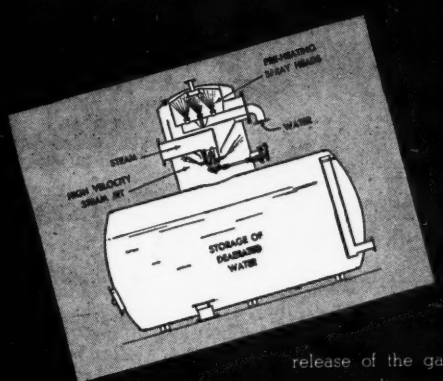
Electrical Drafting Applied to Circuits and Wiring, by D. Walter Van Gieson, First Edition, 5¼ by 8½ inches, illustrated, 140 pages, cloth, published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y., 1945. Price $1.50.

The author's purpose in writing this book has been to fulfill the need for a book which deals essentially with the principles of electrical drafting. The subject of electrical drafting is touched upon in most books on mechanical drawing, but, as the author points out, too often this type of drawing has been disposed of with a few general paragraphs. Such general information is of little practical value to the draftsman who is engaged in the field of electrical drafting and for this reason, this book, which deals primarily with electrical drafting, should be of interest to such draftsman. The aim of the author has been to carry the reader from the simplest form of electrical diagram to those which are more complex by a graded series of drawing plates and explanations, at the same time developing the detailed wiring plan and correlating the equipment-location plan. The application of drafting to the more important branches of electrical work has been his aim. The book is well written and it should be of value to anyone engaged in doing electrical drafting. The author, D. Walter Van Gieson, is Assistant Electrical Engineer, Board of Transportation, of the City of New York.

Electrical Coils and Conductors, by Herbert Bristol Dwight, First Edition, 352 pages, size 5½ by 8½ inches, illustrated, cloth, published by the McGraw-Hill Book Co., Inc., 330 W. 42nd



Deaeration by ATOMIZATION



THE COCHRANE ATOMIZING DEAERATOR is designed primarily to satisfy conditions where the tray type deaerator is inapplicable or disadvantageous, as in the case of corrosive or encrusting waters.

The heating of the water and the release of the gases occur while the water is dispersed by atomization as minute droplets in a steam atmosphere, instead of upon trays.

The water is so finely divided by the action of the atomizer that tremendous surface contact is provided, and the oxygen is recovered in the fraction of a second.

Shown above is a Cochrane vertical atomizing deaerator with a circular atomizer mounted on a horizontal storage tank. Its capacity is 250,000 lbs./hr. and it is installed in the Union Station Power Plant of the Terminal Railroad Association at St. Louis, Mo.

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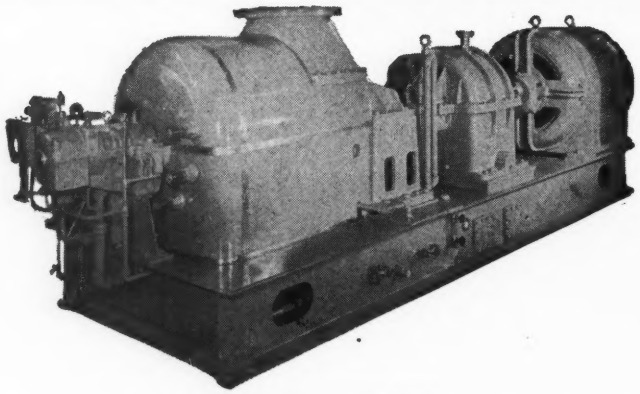
MURRAY
TURBINE GENERATORS



500 KW—PACKAGE TYPE

The unit shown above was designed to deliver 500 KW 50 cycle alternating current on steam at 285# gauge, 700 degrees F., and exhausting condensing to 27 inches vacuum. Thirty identical units were furnished.

Equipment included trip and throttle valve, oil relay governor controlling single throttling inlet valve with hand valve control for partial load operation, all service connections above floor line except generator leads, drain piping brought to one point, and structural steel baseplate. The baseplate is sufficiently rigid so that the unit can be handled in one piece, and installed on the simplest of foundations.

While "Package Type" units are furnished for export for installation in remote areas not previously supplied with power, similar designs can be made for industrial plants for main or standby power supply.

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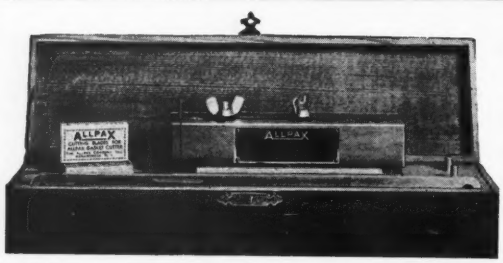
MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY



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The most remarkable tool ever invented.

Write for Booklet

THE ALLPAX GASKET CUTTER

Manufactured by

THE ALLPAX COMPANY, INC.

Distributors everywhere ***Mamaroneck, N. Y.***

Street, New York, N. Y., 1945. Price $5.00.

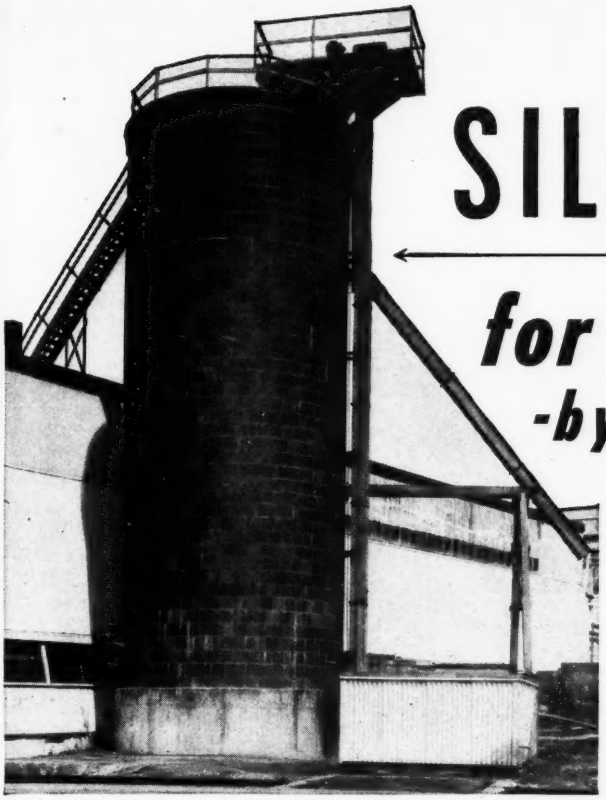
This is a book that should be of value to almost every electrical engineer, because it contains data and information on the electrical characteristics and theory of coils and conductors that would be difficult to find elsewhere. It covers the calculations needed in the design of all types of coils and conductors whether they be used in transformers, bus structures, switch-gear or heating devices. Although a small book, it is compact and its 352 pages contain a wealth of unusually valuable material. The material is classified under 39 different chapter headings. Special attention is given to the calculation of cylindrical coils without iron cores.

Herbert B. Dwight, the author, is Professor of Electrical Machinery at the Massachusetts Institute of Technology.

Transmission Lines Design, Construction and Performance, by Fred C. DeWeese, First Edition, 297 pages, 5¼ by 8¼ inches, cloth, illustrated, published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y., 1945. Price $3.50.

As pointed out by the author in the preface, there has long been need for a comprehensive work dealing exclusively with the design, construction, and performance of lines for the transmission of electric power, in which the material is so presented that it will be useful to those who are interested in the subject, from beginners to more advanced engineers. Mr. DeWeese has endeavored to accomplish this in this book. It is a thorough and practical treatment of transmission lines, covering the subject in a step by step procedure from the simplest problems in design and performance calculations, on through the most advanced phases of the work. With clear explanation and many illustrative examples and typical problems, the book presents both the fundamental and the more involved aspects of electric power transmission engineering and provides data and material applicable not only to transmission line problems but also to the other problems of a similar nature. Special attention is given to modern methods of field work and to the more recent developments in transmission line devices. An idea of the scope of the book can be obtained from the following list of chapter headings: 1, Transmission Systems; 2, Conductors and Circuit Comparisons; 3, Electrical Properties of Conductors; 4, Short Transmission Lines; 5, Medium-length and Long Transmission Lines; 6, Mechanical Design of Transmission Lines; 7, Mechanical Calculations; 8, Sag and Tension Calculations; 9, New Method of Calculating Sag in Long Spans; 10, Line Location and Survey; 11, Transmission-line Devices; 12, Construction of Wood-pole Transmission Lines; 13, Construction of Steel-tower Lines; 14, Performance of High-voltage Transmission Lines with Phase Control; 15, Transmission of Power at Critical Load; and 16, Mathematical Operations and Corona-loss Calculations.

The author, Mr. DeWeese, is General Engineer of the Carolina Power and Light Co.



SILO SYSTEMS

for Coal Handling -by LINK-BELT

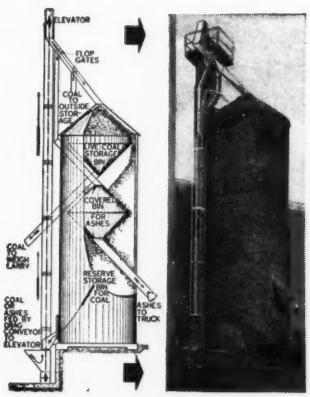
—featuring complete handling equipment

The silo system of handling coal or ashes, or both, many times is the low-cost answer to the problem.

One such example is a Link-Belt silo system at West Area yard of New England Shipbuilding Corporation, South Portland, Maine, featuring conveyor equipment to handle bituminous stoker coal from hopper bottom cars to silo at the rate of 50 tons per hour; and from the silo bottom, over automatic weighing scales, to stoker hoppers in the boiler room at 10 tons per hour. The conveyor equipment consists of Link-Belt BULK-FLO Elevator-Conveyor units, both for filling the hollow tile silo and reclaiming coal from it, and auxiliary feeders, etc.

Since Link-Belt builds a wide variety of handling equipment, we can make a layout to solve any outside-storage problem, with the economic advantages of standardized units. We'll be glad to consult with you on your problem.

Above—Link-Belt silo coal storage system at New England Shipbuilding Corp. The chute at the right of silo is for overflow to ground storage.



FOR BOTH COAL AND ASHES

This illustration shows a Link-Belt silo system with bucket elevator for handling both coal and ashes. Coal may be diverted to ground storage through auxiliary spout. Ashes are discharged to the ash section of the silo by means of a control gate and independent spout.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

10,285

LINK BELT

COAL AND ASHES HANDLING EQUIPMENT

(Continued from page 56)

subject of this recently issued bulletin. It is designated as Form A-1347. The typical examples of the oil working on the job are illustrated and a brief outline of the job the oil has done is included. These sketches show how the oil improved or increased production and cut costs. Sun Oil Company.

48 **Hose, Couplings, Tubing Handbook**—This 72-page handbook is a valuable addition to your engineering data. It is packed with information on flexible hose installation; it presents drawings and photos of typical hose applications; there is a "Wrong and Right" section which is well illustrated with sketches. Chemicals and their effects on this hose are tabulated, as are permissible steam pressures. Step-by-step photos show how to assemble detachable couplings. Ordering information is accompanied by dimensioned drawings. The section on tubing and tubing connectors is equally well done. Packless Metal Products Corp.

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions dictated by space requirement or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies

PRIME MOVERS

49 **Wheel Turbines**—Explanation of 14 advantages; diagrammatic illustrations and explanations of operation; 8 pages. Terry Steam Turbine Co.

50 **Axial Flow Impulse Turbine**—Bulletin S-107; six types described; data for estimates; applications; types, casings; wheels and blades; shafts, nozzles and bearings; overspeed stop and other governor features; lubrication; 8 pages. Terry Steam Turbine Co.

51 **Multi-Stage Turbine**—Bulletin SR-114; Casing, lagging, wheels and blades; shafts, nozzles, bearings; governors; speed changer or synchronizer; governor valve and steam strainer; lubrication; general; 10 pages. The Terry Steam Turbine Co.

52 **Steam Engines**—Bulletin No. 306; Engineering data, tabular material descriptions; 8 pages. Troy Engine & Machine Co.

53 **Generating Sets**—Bulletin No. 108; General descriptions, typical installations, engineering data tables, details of construction, completely illustrated; 24 pages. Troy Engine & Machine Co.

STOKERS

54 **Stoker**—Catalog H; Type H stoker; cross-sectional installation drawing; features of ash discharge; typical installations; 10 pages. American Engineering Co.

55 **Air-Cooled Stoker**—Catalog R-A; features of construction; how timing device works; installation drawings, ash discharge, air cooling features; features of front end driving mechanism; engineering data tables; 20 pages. American Engineering Co.

56 **Water-Cooled Stoker**—Catalog W; drawings of installations; features; furnace views; 8 pages. American Engineering Co.

57 **Spreader Stoker**—Installation views; features of various parts; cross-sectional view of furnace with installation; listed features; 8 pages. American Engineering Co.

58 **Pneumatic Spreader Stoker**—Threefold booklet on the inner page of which there are 30 spirally-bound vertical pages which fold back to tell the story of the stoker, installation, features, construction, principles, engineering, types and models, typical installations; well illustrated; 33 pages. Iron Fireman Mfg. Co.

59 **Poweram Stoker**—Bulletin 7121; essentials of successful stoker; fuel control, fuel conveying, fan capacity, controls, installation; illustrations; 18 pages. Iron Fireman Mfg. Co.

OIL, GAS BURNERS

60 **Oil Burning Systems**—Bulletin 45-1; three types of systems; drawings, tables of capacities and descriptions; photos; 4 pages. Faber Engineering Co.

61 **Mechanical Oil Burners**—Bulletin 45-2; two systems; drawings, tables of capacities and descriptions of units; parts list; 4 pages. Faber Engineering Co.

62 **Oil and Gas Burners**—Bulletin 45-3; combination burner; photos, drawings, tables; 4 pages. Faber Engineering Co.

63 **Oil Burners**—Bulletin 108; Two types of oil burners, A and H; air registers, oil atomizers, drawings; 4 pages. Peabody Engineering Corp.

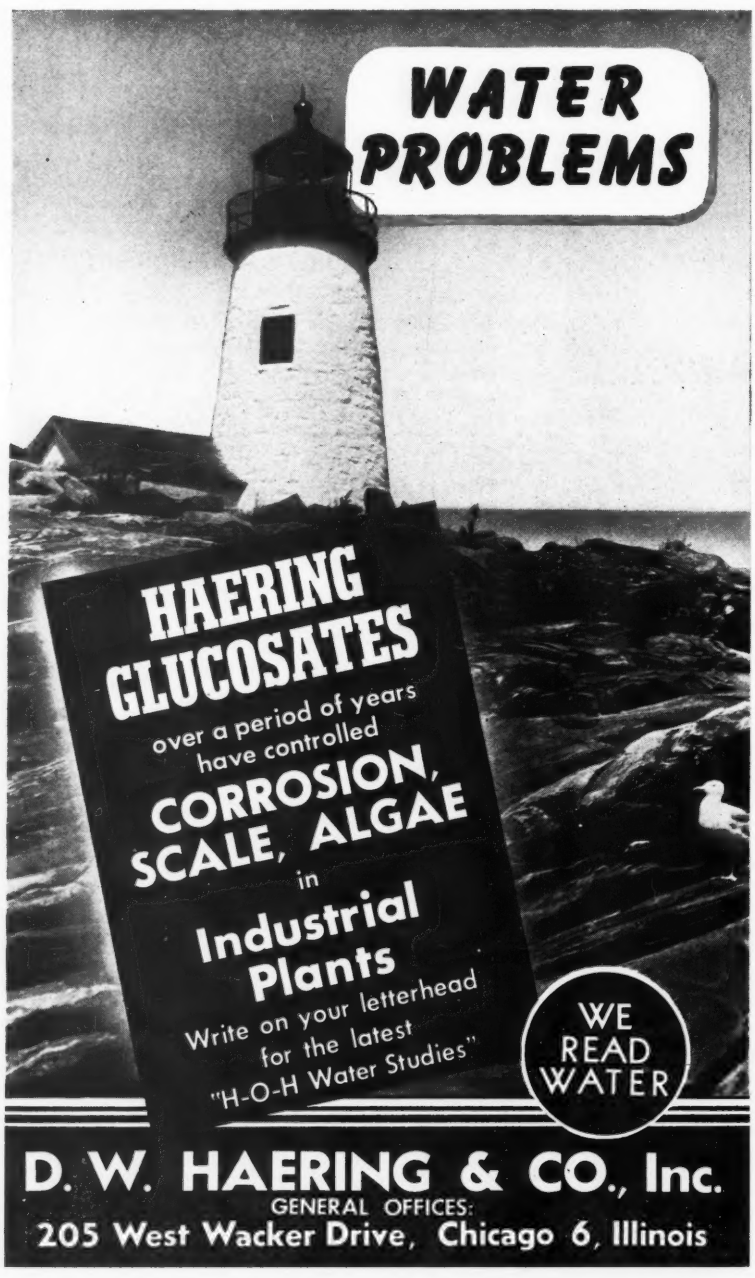
64 **Gas Burners**—Bulletin 203; description of A and H gas burners; cross sectional diagram; photos of atomizers; 4 pages. Peabody Engineering Corp.

65 **Gas and Oil Burners for Oil Refinery Furnaces**—Bulletin 702; details of firing with gas, with oil; photos; drawings; 4 pages. Peabody Engineering Corp.

WATER TREATMENT

66 **Water Treatment**—Control of Fouling Organisms in Fresh and Salt Water, by John G. Dobson. Life history of these organisms; method of control. Wallace & Tiernan Co., Inc.

67 **Industrial Water Treatment**—Microbiological Control of and Through Industrial Waters; spot summaries of improvement of process efficiency and product quality by proper sterilization. Wallace & Tiernan Co., Inc.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Those four points on each end of every WeldELL are small things to look for, but big things to find.

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- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

have everything

68 **Condenser Water Treatment**—Chlorination of Condenser Cooling Water, by R. B. Martin; important considerations in chemical treatment of cooling water circuits. Wallace & Tiernan Co., Inc.

69 **Water Treatment**—Chlorine Destroys Ammonia, by A. E. Griffin. Gives data on use of chlorine for elimination of ammonia from boiler feed water. Wallace & Tiernan Co., Inc.

70 **Index for Calcium Carbonate**—Reprint of paper by John W. Ryznar; tables and charts; 16 pages. National Aluminate Corp.

71 **Water Treatment**—Bulletin 28S; Scale retardent for use in boilers, feedlines, heaters, etc.; drawing of points of application; composition; 4 pages. National Aluminate Corp.

72 **Boiler Feedwater Q & A**—Bulletin 30; 102 questions and answers on various problems of boiler feedwater; 16 pages. National Aluminate Corp.

73 **Water Analysis**—Bulletin 6A; standard methods of water analysis and interpretation of results; 4 pages. National Aluminate Corp.

74 **Water Treatment**—Scale and corrosion control in potable water supply; reprinted paper presented by Hanlon, Steffen, Rohlich and Kessler; 12 pages. National Aluminate Corp.

75 **Algae and Slime**—Bulletin 31; the elimination of algae and slime in cooling systems, paper mills, etc., drawings, photos; 4 pages. National Aluminate Corp.

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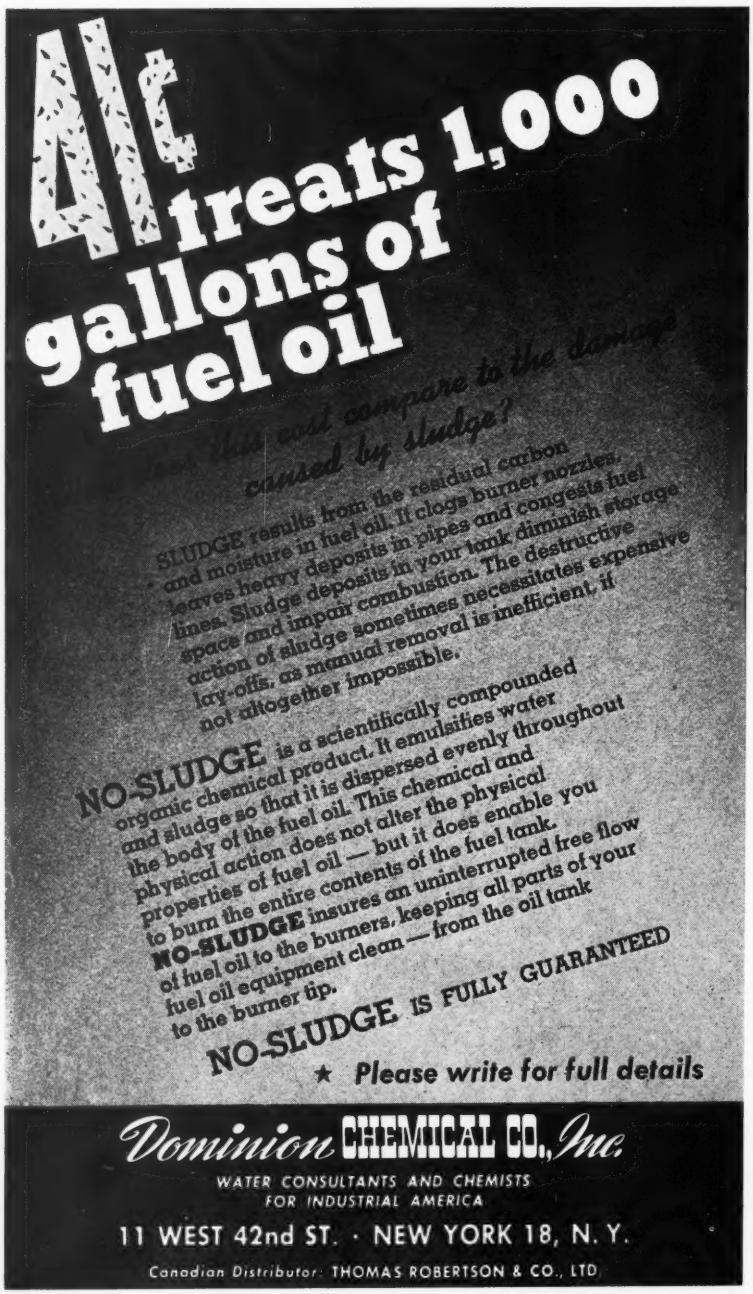
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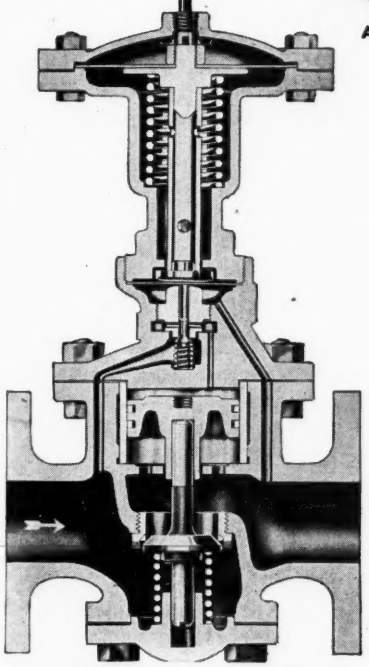

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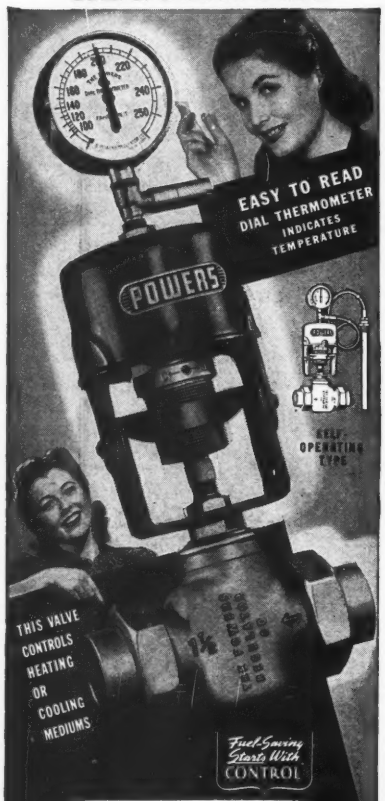

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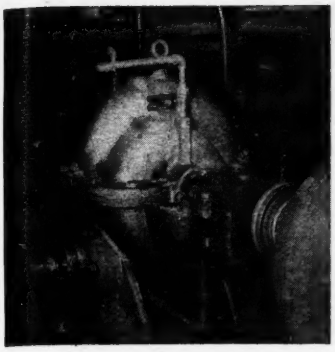

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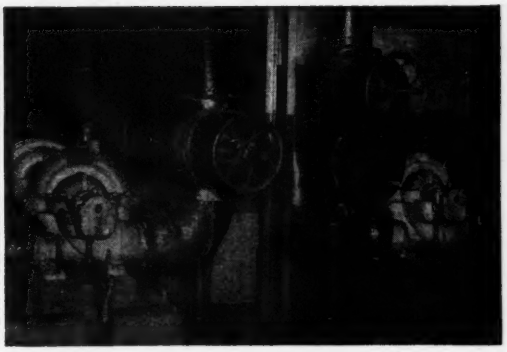

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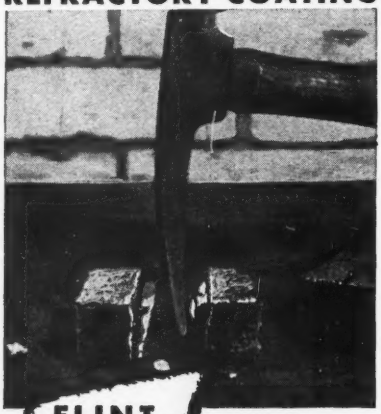

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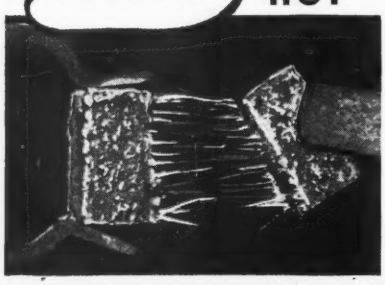

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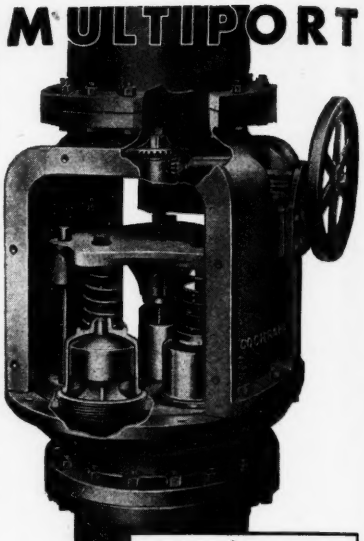

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"To be very conservative, we would say that we are saving 100 tons of coal per month on a 500 H.P. Stirling boiler, and are using very little make up water, with a considerable saving on water softening chemicals, also our cooking time in cooking waste animal material has been reduced 30%."

From a Soy Bean Mill:

"We have two in our soy bean plant—one for each boiler—and we wouldn't be without them for many times the original cost. The oldest one has been in use about five years, I think, and outside of one bearing replacement and occasional repacking, I think we have had no expense on it. The other one has been in service about three years—working constantly 24 hours per day, seven days per week, and as far as I know, the repair costs have been nothing."

We may be able to do as much for you. Anyhow it will cost you nothing to find out. As a general rule, increased production due to the better steam circulation induced by our system and resulting in hotter steam heated units, is worth many times the saving in fuel.

We will gladly analyze your requirements, without cost or obligation, and tell you exactly what we can guarantee to accomplish in your plant. Just drop us a line or give us a ring and you will find us at your service.

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Engineers and Manufacturers

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Otis maintenance man measuring the clearance between brake drum and brake lining. Standard clearance for the brake illustrated is six one-thousandths of an inch — or about twice the thickness of a human hair.

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OTIS MAINTENANCE FOR OTIS ELEVATORS

Every elevator under Otis Maintenance receives attention that is made to order. Every inspection is a personal service; adapted to meet specific conditions, volume of traffic handled, and type of equipment installed.

This service is brought to your building through one of the 245 local Otis offices specializing in your requirements and the needs of your community.

It is important to note that Otis Maintenance does not stop there. Each local office is backed up and supervised by a Maintenance district office, which provides special tools and materials. Back of the districts are ten zone offices providing even greater facilities. Back of the zones is the headquarters organization with all of the engineering, research and production capacity of the manufacturer of more than half of the world's elevator equipment.

Through all of this organization your personal Maintenance service never loses its identity. Individual reports on performance are received and analyzed straight through to headquarters. Every resource of the entire Otis Elevator Company is devoted to making your service meet Otis standards.

Complete, flat rate Maintenance Service for Otis elevators is available through your local Otis Elevator Company office.

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PUMP DISCHARGE
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Your first step in assuring smoother, quieter, more efficient pump discharge, is the installation of Combination SILENT CHECK VALVES.

Note these important money-saving features: 1. Spring-Loaded—when flow ceases, valve is closed without chance of water hammer; 2. Area through valve is 20% in excess of pipe area; 3. Really silent in operation; 4. All valve wear is on easily replaced or repaired parts; 5. Works equally well on Boiler Feed Lines, House Pumps, Liquid and Steam Lines; also used on Foot Valves.

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Competent and conscientious Engineer desires position as STEAM POWER PLANT SUPERINTENDENT or equivalent. Age 43. Two years Technical College. Over 20 years diversified experience mostly supervisory capacity on Efficient Operation, Maintenance and Overhaul of modern steam installations from low to 1400 lb pressure. Powdered Coal, Gas, Oil and Stoker fired, together with all auxiliaries. Desire change after lengthy service with present employer. Available on reasonable notice. Address Box 1514, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Illinois.

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with mechanical or chemical engineering background. Must have proven record in sales management and must be capable of building up an aggressive sales organization in the Chicago territory. We are well known manufacturers of chemicals for the scientific conditioning of industrial water. Write fully education, experience, salary requirements. Box 1518, Power Plant Engineering, 53 West Jackson Blvd., Chicago 4, Illinois.

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Long established and progressive manufacturer of Boiler Water Treatment and Kindred Products has money-making opportunities in the Midwest, South and East for aggressive salesmen—exclusive territories—liberal commissions—send full details, selling experience, etc., to

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Desired by nationally known manufacturer of electrical and mechanical control equipment for industrial applications. Technical sales background required. Salary plus commission. In reply give full details.

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Chicago 4, Illinois

SALES ENGINEERS!

With mechanical or chemical engineering background. Excellent opportunity for hard workers with real sales ability in key locations all over the United States. We are well known manufacturers of nationally advertised chemicals for the scientific conditioning of industrial water—car essential; experience in this line unnecessary—our organization knows about this advertisement. Write fully age, education, sales experience, salary requirements.

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REPRESENTATIVE AVAILABLE—Northern Illinois and Wisconsin. Professional Engineer well acquainted with leading power plants in this territory wants one or two additional high-grade lines. Box 1516 Power Plant Engineering, 53 West Jackson Blvd., Chicago 4, Illinois.

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Whatever combination of conditions your springs must fight...

CORROSION • RUST • HEAT • COLD • HIGH STRESS • FATIGUE

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COMPRESSION • EXTENSION • TORSION • SPIRAL • FLAT • CLIP • RETAINER • GARTER • BANANA

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There is no need to put up any longer with repeated troubles that can be avoided by using INCO Nickel Alloy springs for corrosive conditions and elevated or sub-zero temperatures.

Now, rustless, high-strength springs can be made of five different INCO Nickel Alloys to withstand corrosive attack and temperatures up to 750°F.or even higher.

And they cost so much less than special alloy springs that it is practical to use them for any application where heat, corrosion or fatigue are causing you trouble with ordinary spring parts.

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HERE'S A CHANCE TO GET RID OF THE SPRING PROBLEM THAT HAS BEEN BOTHERING YOU

Send for "ANALYZING THE SPRING PROBLEM." When you get this simplified worksheet, jot down the data about your spring problem and what you want in a spring. The information you supply, plus our service records and test data, will enable us to judge which material can be recommended for your particular service. Then, we will cooperate with your spring manufacturer to work out the answer to your problem. That is all you need to do. Write today for "ANALYZING THE SPRING PROBLEM."

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MARION Gulf Stream Hot Water Heater

Utilize low pressure or live steam to assure abundant hot water. GULF STREAM heats swiftly through four concentric tubes, including outer shell, providing intimate steam and water contact.

● Steam fills central tube and annular space between two middle tubes. Water enters through pipe at extreme left, fills annular space between central tube and one surrounding it and between shell and next inner tube. Slidable packing glands at shell ends provide for expansion and contraction, prevent strains and leaks. Condensate moves to trap and returns to system, conserving all heat value. Here is ECONOMY and DEPENDABILITY.

Line ranges from 4" to 8" in diameter, 4' to 12' in length. Capacity ratings with steam at 25 lbs. are 370 to 4,335 GPH with temperature rise from 50° to 180° F. Installation requires little space. May be near floor line, ceiling or on wall. Standard design allows for 150 lbs. working pressure.

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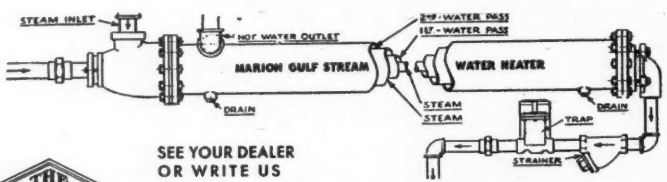

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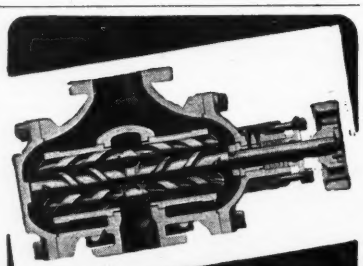

THE IMO PUMP IS RELIABLE BECAUSE IT IS SIMPLE....

The IMO pump has only three moving parts and no valves, timing gears, pistons, cams, vanes or delicate adjustments to get out of order or require maintenance.

IMO pumps have an outstanding record of trouble-free performance in lubrication, hydraulic, governor and fuel oil services.

For further information send for catalog I-135-G.

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A Fast Way to Strip Paint from Transformers

Next time you paint-strip transformers, use the Oakite Hot Flow-On Method to obtain these five time- and money-saving features! Your nearby Oakite Technical Service Representative will give you tank-installation details and solution-temperature specifications.

1. **COMPLETE REMOVAL** down to the bare metal of any number of previous coats—10 or 20—by means of powerful Oakite STRIPPER in the solution.
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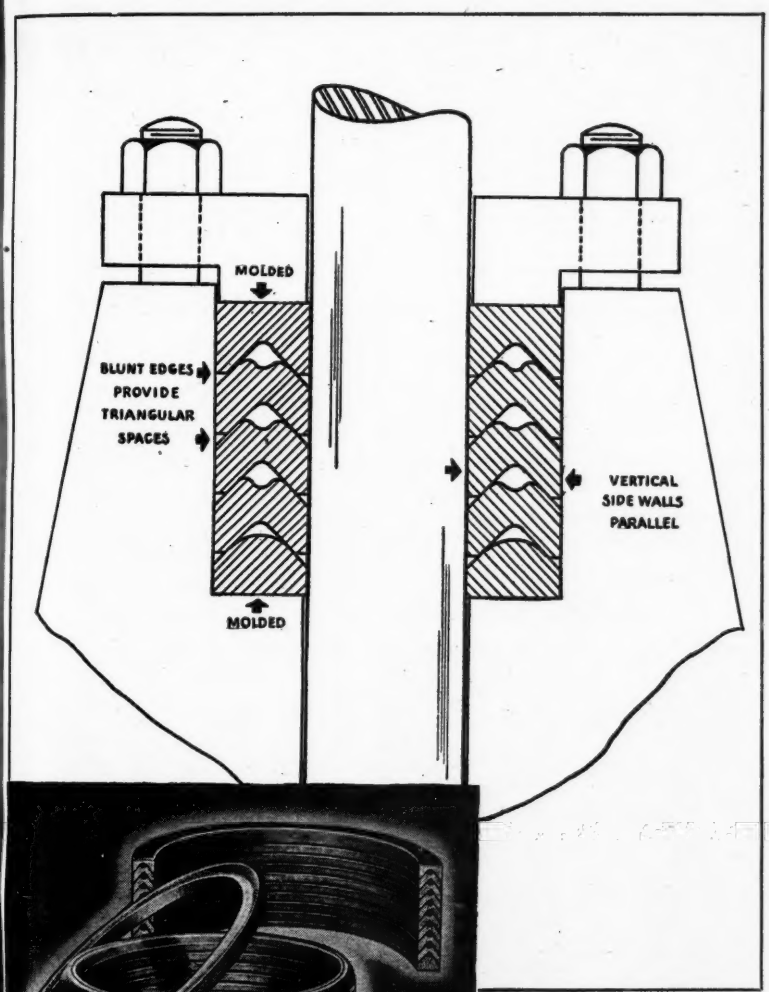
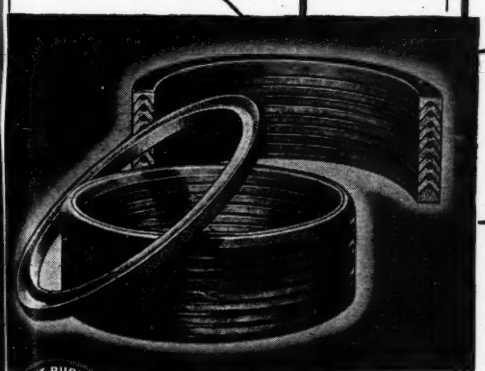
Longer Life FOR RODS AND PLUNGERS WITH UNIQUE U.S. MATCHLESS PACKINGS





No Other Packing Has All These Advantages

BLUNT EDGES—Give more efficient shape; allow fabric to reach end of packing, providing uniform strength throughout. In conventional packing (feather-edge design) fabric cannot be forced into sharp edge, leaving unprotected soft-rubber end to cause curling and chipping.

TRIANGULAR SPACES—Blunt edges provide triangular spaces for trapping loose scale, oil, etc. Result is less friction, less power required, and scaling does not score entire length of packing set.

PRESSURE BREAK—The triangular space of each ring breaks the pressure more quickly than ordinary types without this feature. With "Matchless" design, automatic action is faster, more effective.

MOLDED END RINGS—Tests show the female ring and the one next to it take 70% of the pressure on the set. In "Matchless" *all* rings are molded, are of proper density, and have no sharp edges to break off, as on end rings cut from slab.

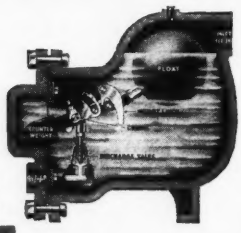
EASY TO INSTALL—Matchless Packing has parallel side walls, while conventional packings are made with varying degrees of wall flare. "Matchless" rings slide easily into stuffing box; the flare type requires considerable effort and time.

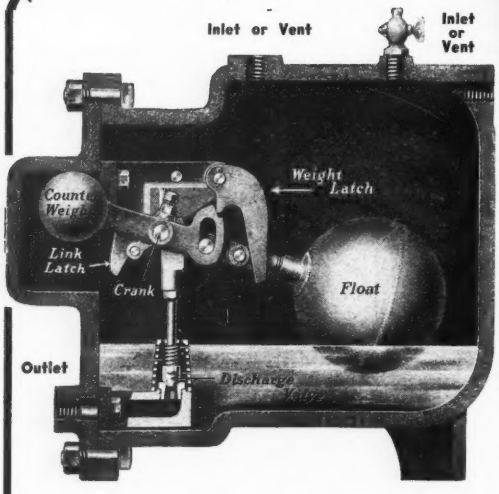
The self-adjusting, automatic action of "Matchless" results in reduced wear and tear on rods and plungers, minimizes friction and keeps down packing costs. For hydraulic equipment, presses, rams, triplex pumps, outside packed pumps, and swivels on rotary drilling rigs. Write for details.

UNITED STATES RUBBER COMPANY

1230 Avenue of the Americas • Rockefeller Center • New York 20, N. Y.

2 WAYS TO *Stop* *"Leaky-Trap"* TROUBLE





Here are two reasons why these two Nicholson weight-operated traps are such dependable solutions of the leaky-trap problem: first, a positive fluid seal is maintained over the discharge valve at low level; second, even in superheated conditions the valve always remains leak-proof, due to its weight operation . . . Also piston-operated and thermostatic traps, for every power and process purpose.

Catalog 444 or

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160 OREGON ST., WILKES-BARRE, PA.

LOW COST DEMINERALIZED WATER

WILL REPLACE EXPENSIVE DISTILLED WATER IN THE MAJORITY OF APPLICATIONS

★ Demineralized Water suitable for many requirements demanding distilled water, can now be obtained at a fractional part of the cost of distillation. Belco deliveries are surprisingly rapid.

MODERNIZE YOUR ZEOLITE WATER SOFTENERS

The new Belco zeolite will increase the capacity of industrial softeners up to six times as much. Ideally suited for modernization of present equipment. Belco engineers are always available to help you.

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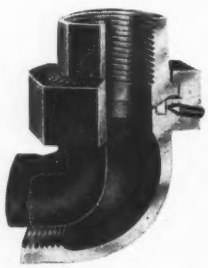
INDUSTRIAL PROCESSING EQUIPMENT SINCE 1892

Simplify YOUR PIPING MAINTENANCE *with* JEFFERSON UNIONS



with the RECESSED BRASS SEAT

The *brass-seating feature* of all Jefferson Specialty Unions means important savings in piping maintenance because there are fewer joints involved at points where unions are used; also guards against shutdowns because it gives leak-proof tightness without undue pressure.

The 90 deg. Union Elbow shown is representative of the complete line of Jefferson Specialty Unions to meet all piping applications. Write for descriptive catalog or get in touch with your nearest distributor.

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601 West 26th St., New York 1, N. Y.
Factories at Lexington 73, Mass., and Lockport, N. Y.

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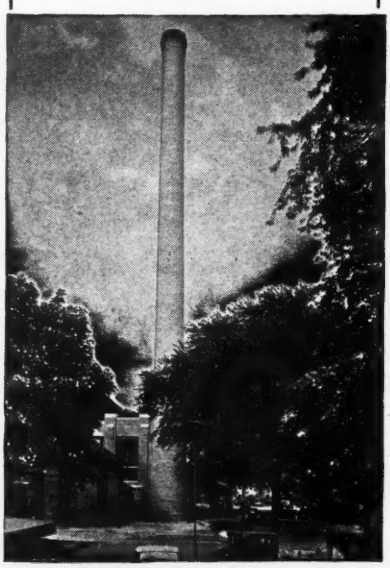

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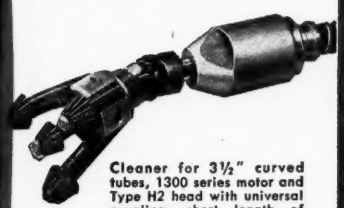
Quick DEATH to boiler scale

The 1300 series motor connected to Type PN cutter head for 3" straight tubes.



Cleaner for 3½" curved tubes, 1300 series motor and Type H2 head with universal coupling, short length of hose at rear of motor.

1300 series cleaner for 3" curved tubes with universal joint and drill, short length of hose connected to rear of motor.

1300 series motor equipped with vibrator head for use in removing scale from the outside of fire tubes.

Y-257

For curved tubes a short-bodied 1300 series motor is used with universal joint between motor and Quick Repair head and a short length of hose at the rear to give flexibility.

Write today for the Elliott boiler tube cleaner bulletin. If you have an unusually tricky or difficult tube cleaning problem, consult with the nearest Elliott specialist. We will put you in touch.

They call them scale-killers in many boiler rooms. These Elliott (Lagonda Type) 1300 series tube cleaners zip into action and quickly run through scale-clogged tubes leaving them clean as a whistle and ready for business again.

Tube cleaning is a one-pass job with an Elliott cleaner. No need to run it through a second time. And no need to run the motor while the cleaner is being pulled back. Simply haul back and get going on the next tube.

Maintenance men like the way Elliott cleaners operate. They know these cleaners help them get through with the job faster and easier. They like the refinements that make these cleaners swift, powerful — and troublefree.

Rugged cutterheads, all-over lubrication system (including front bearing), super-efficient motor and a streamlined body that gets around tube turns, help make Elliott tube cleaners the kind to have in your own boiler room. Write today for fully detailed bulletin.

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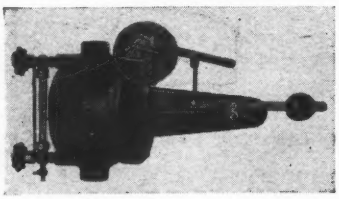
ELLIOTT 1300 SERIES TUBE CLEANERS

DAVIS FLOAT BOXES for Liquid Level Control of:

- TANK VALVES
- SIGNAL SWITCHES
- MOTORS
- OTHER EQUIPMENT

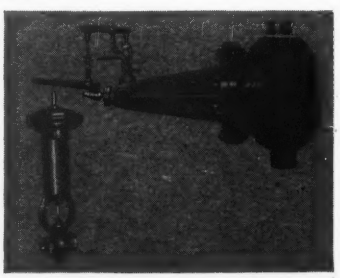


Davis No. 164 Float Box with Mercury Tube Switch.

DAVIS Float Boxes are used in connection with closed tanks where fluctuation of the fluid level within the tank is the governing factor in the control of all types of electrical switches, control valves, pilot valves (for operation of diaphragm motor valves), motors and other equipment. David fluid control equipment also includes internal float units for direct or pilot operation. Whatever your requirement may be, Davis can supply you with a combination of float box and control valve to make your control accurate, positive, and dependable.

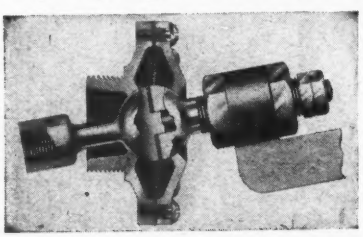
Drop us a card today for detailed information on the Davis line. Ask for Bulletin 101AA. DAVIS REGULATOR COMPANY, 2508 S. WASHTENAW AVE., CHICAGO 8, ILL.

Davis No. 162D Packless Float Box with Pilot Valve and No. 14 Diaphragm Motor Valve.



DAVIS DIA-BALL TRANSMISSION UNIT

A patented, leakproof, corrosion resistant packless assembly eliminating the packing box on Davis Float Boxes and Control Valves.



Especially recommended for vacuum service or for use with volatile and inflammable fluids where a packing box is objectionable because of leakage. For pressure up to 300 lbs. and temperatures up to 450° F.

DAVIS VALVES

DAVIS REGULATOR CO.

POWER PLANT Construction News

Ariz., Phoenix—Schenley Distillers Corp., 350 Fifth Ave., New York, N. Y., plans installation of electric power equipment in new distillery on 80-acre tract of land near Phoenix, comprising a main six-story building and several smaller structures. A granary consisting of nine steel tanks, each with capacity of 30,000 gal, will be installed, as well as a steel water tower. A power substation will be built. Proposed to begin work soon. Entire project will cost close to $1,000,000.

Calif., San Francisco—Pacific Gas & Electric Co., 245 Market St., plans expansion in generating station "P," Evans Ave., Hunters' Point district, including addition to building and installation of two 100,500-hp turbine-generators and auxiliaries, high-pressure boilers and accessory equipment. Also will enlarge switchyard and make extensions in transmission lines. Entire project reported to cost close to $19,000,000. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Calif., Santa Clara—Storitcold Co., 1300 Webster St., Oakland, Calif., plans new cold storage plant at Grant and Reed Sts., Santa Clara, consisting of two one-story buildings, 98 x 260 ft, estimated to cost approximately $325,000, with equipment. Frederick H. Reimers, 79 Post St., San Francisco, Calif., is architect.

Conn., Bridgeport—Casco Products Corp., 512 Hancock Ave., automobile accessories, has plans for new boiler house at factory, 40 x 60 ft, and erection will proceed at once. Installation will include oil-fired boilers and accessories. Westcott & Mapes, Inc., 109 Church St., New Haven, Conn., is consulting engineer.

Conn., New Haven—United Illuminating Co., Temple St., has plans for addition to English generating station, Grand Ave., 75 x 200 ft, and 150 ft high. Additional equipment will be installed for increased capacity. No official estimate of cost announced, but reported in excess of $4,000,000. Westcott & Mapes, Inc., 109 Church St., New Haven, is consulting engineer.

Fla., Tallahassee—State Improvement Commission, State Capitol, C. H. Overman, director, plans central-heating plant and underground steam distribution system for Capitol Center and Florida Agricultural and Mechanical College. Cost estimated about $685,000. Bids will be asked late in fall. Maurice H. Connell, Langford Bldg., Miami, Fla., is consulting engineer.

Fla., Tavernier—Florida Keys Electric Cooperative Association, Inc., plans extensions in power plant, including installation of new Diesel engine-generator unit and auxiliary equipment. Also will construct new electrical distribution lines and service facilities. Entire project will cost $395,000, and financing in that amount has been arranged through Federal aid.

Ill., Chicago—Commonwealth Edison Co., 72 W. Adams St., plans improvements in Northwest generating station, 3400 N. California Ave., and will begin work soon. No estimate of cost announced. Company also will build addition to Roseland power substation, 10847 S. Michigan Ave., including one-story switchhouse, 46 x 96 ft, and transformer court, 55 x 125 ft. Cost estimated approximately $275,000. Holabird & Root, 333 N. Michigan Ave., are architects for last noted.

Ind., Decatur—Board of Public Works has plans maturing for expansion in steam-electric generating station, including installation of new 10,000-kw turbine-generator unit, surface condenser, centrifugal pumps and auxiliary equipment. Cost estimated about $1,000,000. Emery, Marker & Emery, Toledo Trust Bldg., Toledo, Ohio, are consulting engineers.

Iowa, Burlington—Raytheon Mfg. Co., Waltham, Mass., radio apparatus, rectifiers, transformers, etc., plans installation of electric power equipment in new branch plant at Burlington, comprising main one-story building, 220 x 420 ft, and several auxiliary structures. A boiler

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company — "Bridgeport" BRASS — *Headquarters for BRASS, BRONZE, and COPPER*

Corrosion-Resistant Tubing Vital for Refrigeration Equipment

Because the operation of refrigeration equipment generally comes under the direction of the power plant and marine engineer, a brief discussion of the corrosion problems involved with various types of refrigerants and available corrosion-resisting alloys, may prove helpful.

Refrigeration on board ship, in use for many years, has been growing by leaps and bounds. Increasing quantities of perishables are being transported across wide oceans, and indications are that there will be more widespread use of air conditioning for the health and comfort of passengers and crews. It is anticipated that fishing vessels will be equipped with facilities for "quick freezing" of their catch at sea.

On land, refrigeration has long been widely used in the meat packing industry; for ice making and beverage cooling; for "quick freezing" of fruits and vegetables; and for food locker systems.

Industrial Refrigeration

The power plant engineer is coming more and more into the industrial refrigeration picture. Many power plants are designed to supply refrigeration in connection with manufacturing processes and with the handling and storage of gas products and special materials. In some cases, refrigerating equipment is being driven directly by the turbines.

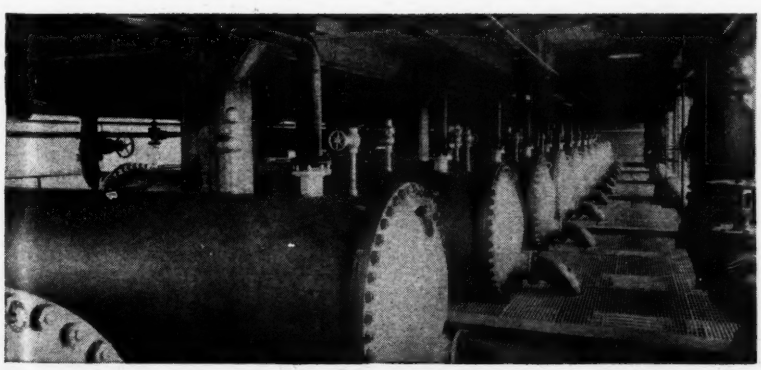
Certain substances such as rubber, as well as material used in the manufacture of synthetic rubber, plastics and fibers, must be stored at sub-atmospheric temperatures. Various liquors used in the manufacture of synthetic fibers must be cooled during the process. Refrigeration also plays an important part in the manufacture of penicillin and many other pharmaceuticals. An understanding of the corrosion problems involved in the operation of refrigeration equipment will help engineers reduce maintenance to a minimum.

Types of Corrosion Encountered

Since refrigeration systems may involve many miles of tubing which must handle corrosive liquids or gases, selection of alloys capable of standing up under service conditions is one of the most fundamental problems confronting the power plant engineer.

The most common types of corrosion which involve tubing in refrigeration systems are:

1. Corrosion by the refrigerant (ammonia, methyl chloride, Freon, etc.).
2. Corrosion by brine (sodium chloride or calcium chloride solutions).
3. Corrosion by air (atmospheric corrosion—either where air is cooled, or where air is cooling the refrigerant).
4. Corrosion by cooling water (fresh or sea water).
5. Corrosion by the product being cooled (beverages, chemicals, liquors or gases).



Ammonia condenser, horizontal shell and tube, multi-pass, closed type.—*Courtesy York Corp., York, Pa.*

Refrigerant Affects Alloy Selection

Where refrigerants such as Freon or methyl chloride are used, copper and copper-base alloys have proved to be most satisfactory from the standpoint of corrosion resistance and long life. For low velocity sea water, arsenical Admiralty stands up well in contact with water and the refrigerant. For fresh water or where air is the cooling medium, copper is very widely used. If there is a possibility of air impingement corrosion because of high sea water velocities Cuzinal (aluminum brass) is superior to Admiralty. For extremely high sea water velocities cupro nickel is recommended. In cases where air is cooled or where air is cooling the refrigerant, fins are attached to the copper or copper alloy tubing for greater heat transfer efficiency.

Ammonia refrigeration is widely used for meat packing, artificial ice making and "quick freezing", as well as in processes involving petroleum refining, manufacture of synthetic rubber and fibers, pharmaceuticals, chemicals and many others. It presents a special problem since severe double corrosion is involved. Steel pipe rusts away from contact with water, and copper-base alloys do not stand up when in contact with moist ammonia. Bridgeport's Duplex Tubing, consisting of two tubes of different metals drawn together, with steel to the ammonia side and copper or a copper-base alloy to the water side, is gaining wide acceptance because it stands up better than steel tubing.

Preventing Taste And Color Contamination

In addition to overcoming severe double corrosion problems, Duplex Tubing can be used to prevent product contamination from the standpoint of taste or color. For example, in a methyl chloride refrigeration system it is desirable to use a copper-base alloy in contact with the refrigerant and aluminum in contact with such products as fruit juices, food products, certain chemicals and drugs.

Bridgeport's Duplex Tubing is available in many combinations—Admiralty, aluminum brass, aluminum bronze, copper, cupro nickel, Muntz Metal, red brass or yellow brass combined either inside or outside with aluminum, Monel, nickel, low carbon steel or stainless.

Technical Service Department

Bridgeport's Technical Service Department, composed of an experienced group of practical men, is available to help solve your corrosion problems by aiding in the selection of the proper tubing alloy. Inquire through your nearest Bridgeport office. In the meantime write for your copy of Bridgeport's 112-page Condenser Tube Manual.

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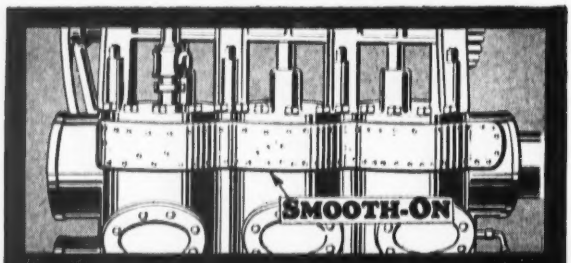
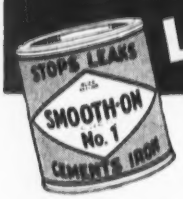
This insert appears in the September, 1946 issues of MARINE ENGINEERING, PACIFIC MARINE REVIEW, ELECTRICAL WORLD AND POWER PLANT ENGINEERING and has a total circulation of over 77,553 to executives, engineers and technicians in the marine power fields.





LEAKING STOPPED

in badly cracked cylinder block

A long crack developed in a 15"x12" triplex geared power pump in a Tennessee plant. It extended through all valve chambers, valve decks and one partition between plunger cylinders. The Smooth-On repair shown above put the pump back in service.

First the entire crack was filled in with Smooth-On No. 1 Iron Repair Cement. Then a shaped metal patch, coated with Smooth-On, was bolted through valve chamber covers and valve decks into solid iron. After the Smooth-On had hardened, the pump resumed operation without leakage.

For more than 50 years, Smooth-On No. 1 has been a repair standby with mechanics, engineers and maintenance men, for sealing cracks, stopping leaks and tightening loose parts economically and effectively. It makes repairs that stay tight, because Smooth-On expands slightly as it sets to metallic hardness.

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house will be built for central-heating service. Entire project reported to cost over $600,000. Work will begin soon.

Kan., Belleville—Municipal Water and Light Dept., plans extensions and improvements in power plant, including installation of new Diesel engine-generator unit and auxiliary equipment. Cost estimated close to $200,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

Kan., Iola—Town Council plans extensions and improvements in municipal steam-electric power plant, with installation of new generator unit and auxiliary equipment, estimated to cost about $415,000. Financing in part will be arranged through Federal aid. Brink & Dunwoody, Iowa, are consulting engineers.

La., Haynesville—Haynesville Electric Refrigeration Cooperative, Inc., recently organized, plans new refrigerating plant with locker system. Cost about $55,000. Financing has been arranged through Federal aid and work will begin soon.

Minn., Ada—Land O' Lakes Creameries, Inc., 2201 N. E. Kennedy St., Minneapolis, Minn., dairy products, plans addition to power house at branch factory at Ada, about 36 x 40 ft, with installation of new generator unit and auxiliary equipment. Max O. Buetow, 1931 University Ave., St. Paul, Minn., is architect.

Mo., Bowling Green—Town Council plans new municipal power plant, using Diesel engine-generator unit and auxiliary equipment. Also new electrical distribution system. Cost about $138,200. Financing in part has been arranged through Federal aid. Plans will be prepared soon.

Mo., Excelsior Springs—Town Council has had surveys and estimates of cost made for a proposed municipal power plant and electrical distribution system, approximating $675,000. Burns & McDonnell Engineering Co., 107 W. Linwood Blvd., Kansas City, Mo., is consulting engineer.

Mo., Kansas City—Sheffield Steel Corp., Sheffield Sta., steel products of various kinds, plans installation of electric power equipment in new additions to mill, comprising several one-story buildings. Cost estimated about $500,000. Work will begin soon. Company is a subsidiary of American Rolling Mill Co., Middletown, Ohio.

N. Y., Jamestown—Board of Public Utilities, City Hall, is considering expansion in steam-electric generating station for considerable increase in present capacity. Cost reported about $750,000.

Ohio, Cleveland—Perfection Stove Co., 7609 Platt St., cook stoves and ranges, plans installation of electric power equipment in new one-story addition to branch plant at 1135 Ivanhoe Rd., about 435,000 sq ft floor space, reported to cost over $1,700,000, with machinery. Work will proceed at once.

Okla., Muskogee—Water Dept., City Hall, plans new filtration plant and pumping station, with motor-driven pumping units and accessories, for municipal waterworks. Cost estimated about $530,000. Proposed to arrange financing in part through Federal aid.

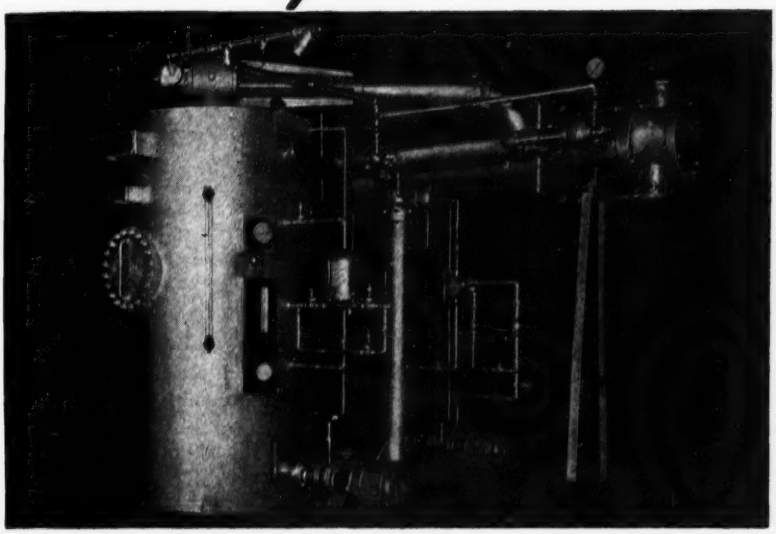
Tenn., Nashville—Nashville Corrugated Box Co., 815 Foster St., corrugated boxes and containers, plans installation of electric power equipment in new one-story addition, estimated to cost about $200,000, with machinery. Erection will begin at early date.

Utah, Nephi—Thermoid Co., Whitehead Rd., Trenton, N. J., rubber products, plans installation of electric power equipment in new branch mill at Nephi, consisting of a main one-story processing and production building and auxiliary structures, reported to cost over $400,000, with machinery. Micklewright & Mountford, 243 E. Hanover St., Trenton, are architects; Ashton & Evans, Beneficial Life Bldg., Salt Lake City, Utah, are associate architects.

Va., Glasgow—Lees-Cochrane Co., Glasgow, carpets and rugs, plans installation of electric power equipment in new one and multi-story addition, estimated to cost over $1,000,000. Work will begin soon. Main offices are at Bridgeport, Pa.

Wis., Fond du Lac—Wisconsin Power & Light Co., Madison, Wis., plans extensions and improvements in generating station at Fond du Lac, including installation of two new boilers and auxiliary equipment. Work will begin soon.

For every process requiring chilled water



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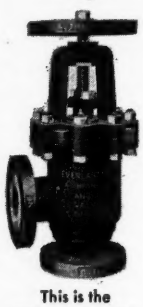

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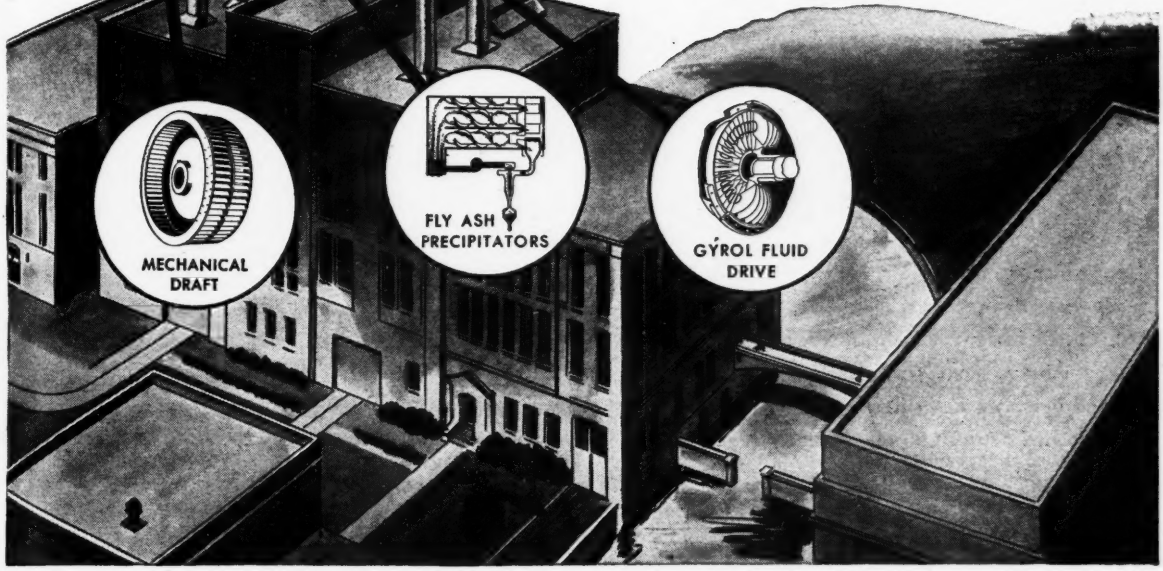

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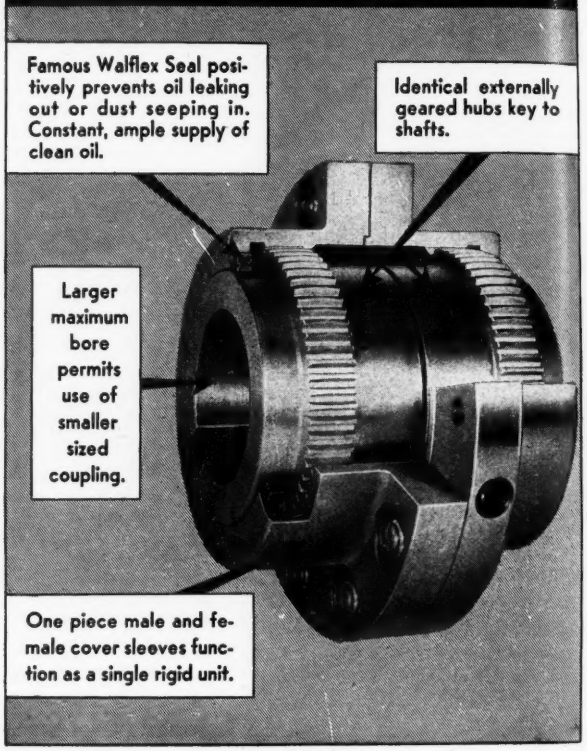
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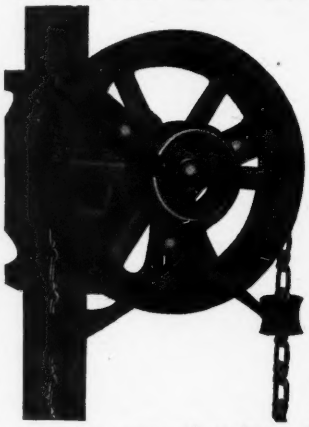

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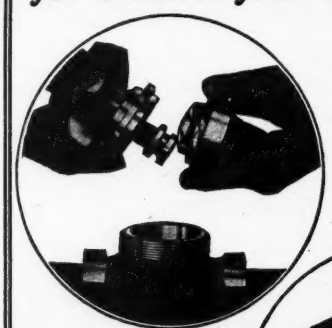

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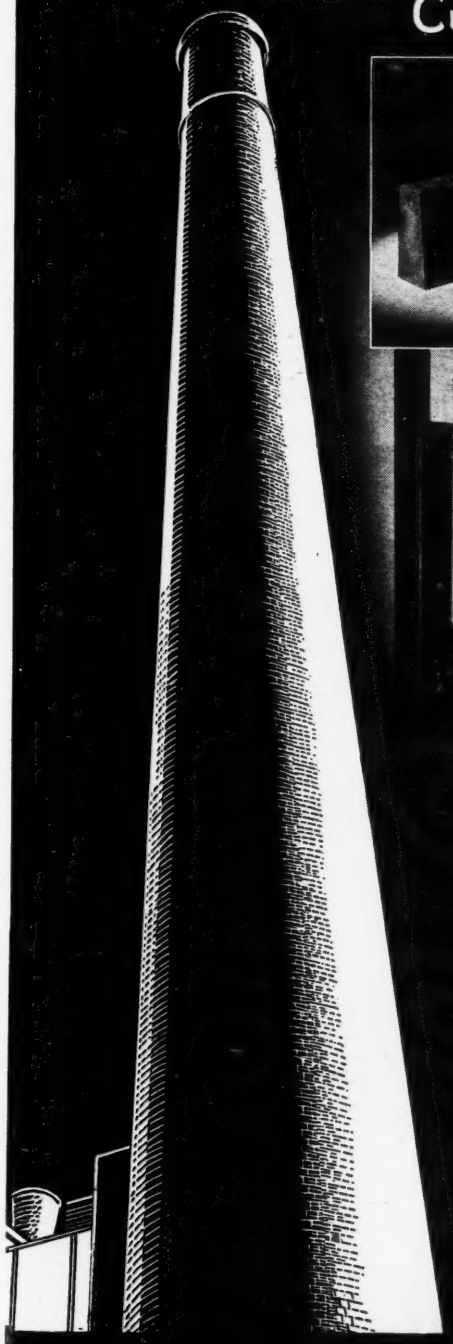

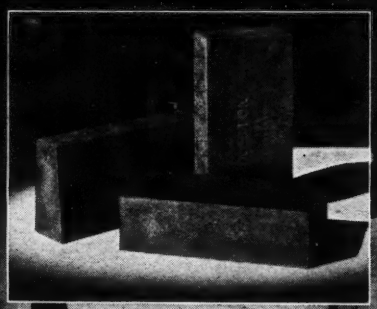

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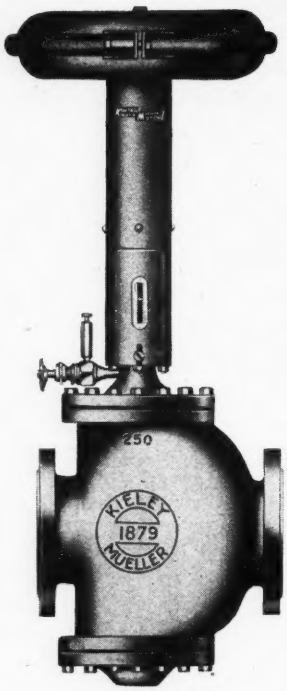

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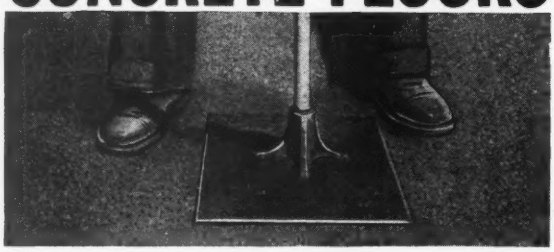

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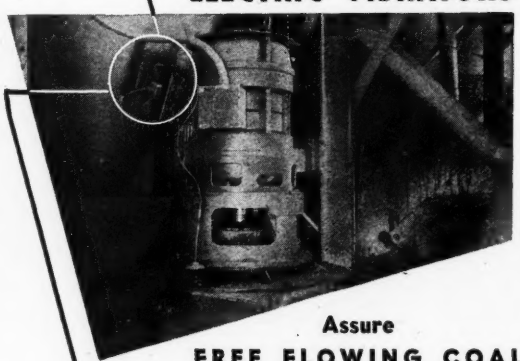

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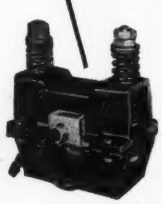

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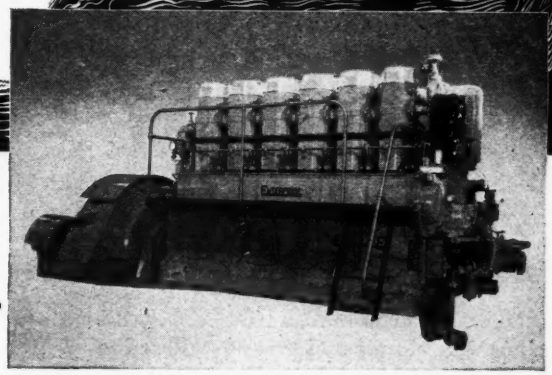

Continuous operation . . .

Above, ENTERPRISE 600 HP DSG-6 Diesel Engine, of the type used by the Mexico City dredge

Here's *proof* that ENTERPRISE Diesels offer the kind of dependability dredge operators must have for efficient—and profitable—operation! The entire sewage disposal of Mexico City is handled by the ENTERPRISE Diesel-powered dredge sketched above . . . twenty hours a day, back and forth along a 60-mile channel, for an estimated three-year operating job . . . with two years of continuous service to date! The same sturdiness is built into ENTERPRISE Diesels powering dredges for mining, harbors and channels, construction and other industrial applications.

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Packings can help you

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Quaker began manufacturing rod packings when engines were simple and pressures were low.

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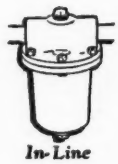
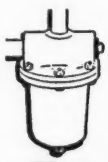
WHEN

regular steam traps won't do--



In-Line



Elbow

● Use Anderson specific purpose traps for installations where a regular trap won't do. For example—on higher pressures and temperatures use the Steel Series Super-Silvertop; for air elimination even when pressures drop (as overnight) to as little as a fraction of an ounce, use the Super-Silvertop series "B" traps; for handling large volumes of air, call for Thermal Air Eliminator equipped Super-Silvertops.

Whatever your needs may be, there's a Super-Silvertop that fills the requirements. Find out more about these Anderson steam traps—write today for *your* copy of "How To Choose A Steam Trap".

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PREVENTS EFFICIENT HEAT TRANSFER

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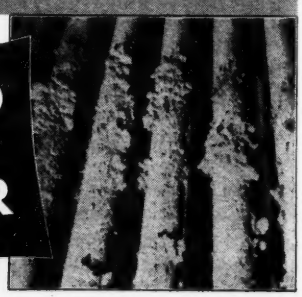

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Gamlenite is safe, non-explosive, can be used in all types of boilers. It is guaranteed unconditionally! Ask our nearest district office for details, or send for Bulletin 454.

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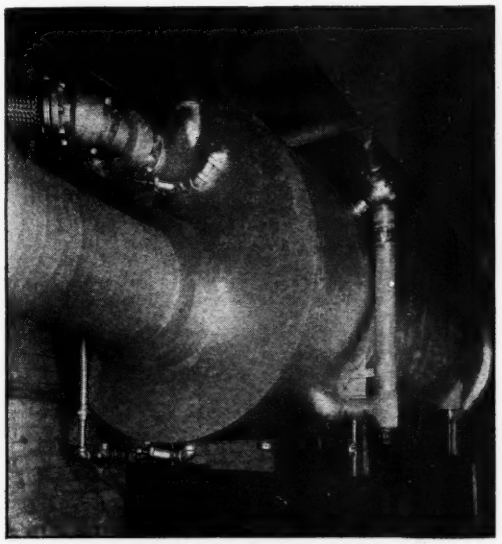
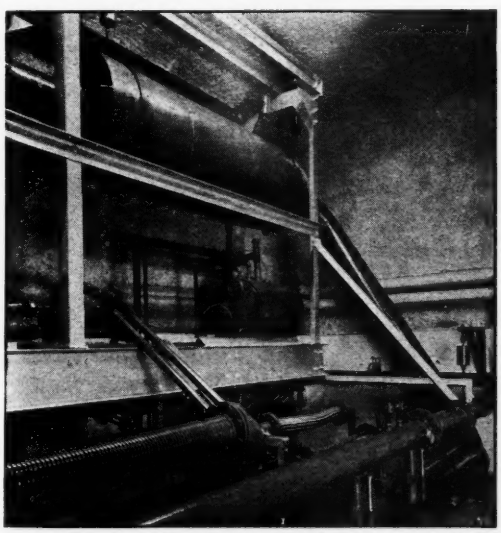
QUIET PLEASE

--- hospital upstairs



Maxim Heat Recovery Silencer uses waste exhaust heat to produce steam.



Maxim Intake Silencer reduces intake noise to a minimum.

A hospital is one place where noise cannot be tolerated, one place where engine silencing equipment must meet the most critical requirements.

At the Lenox Hill Hospital in New York a 750 h.p. Worthington Diesel is Maxim equipped for "hospital quiet" operation. But the Maxim equipment in this case goes further than silencing. The Maxim Heat Recovery Silencer (shown top left) in the exhaust line provides low pressure steam for a multitude of uses throughout the hospital. The picture at the bottom shows a Maxim Intake Silencer which eliminates intake noise.

This installation, supervised by Francisco and Jacobs, engineers and architects of N. Y., is a good example of the advantages of Maxim's complete line of silencing equipment. Not only is a very critical silencing problem solved, but economy in operation is made possible by using the waste exhaust heat to produce an extra "fuel free" supply of steam in this hospital where a large demand for steam is constant.

If you would like more information about Maxim Heat Recovery Silencers send for bulletins WH-100, WH-102, WH-103.

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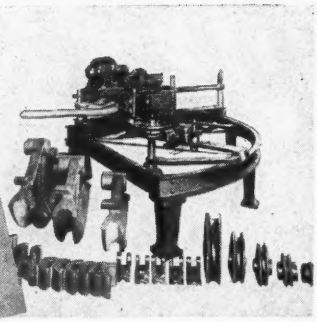

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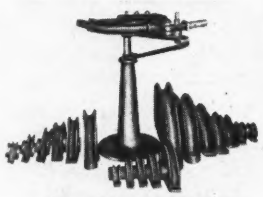

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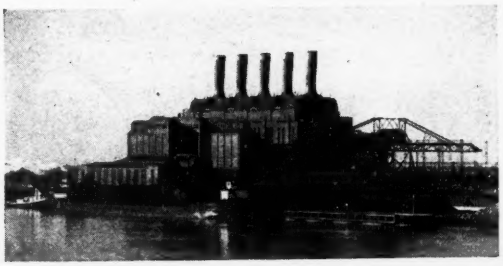

The performance of two large "Pennsylvania" Bradford Breakers at this Station, installed in 1923 and 1926, has again proven the endurance and low cost operation of this type, in service where unfailing dependability is a "MUST."

As a result of this performance, duplicate Bradfords were installed in a later Station of the same system.

Over 60 of these Bradford installations are in Central Station service in the U. S. A.

"Pennsylvania" Bradford installations, at home and abroad, now have capacity for preparing well over 100,000,000 tons per annum.

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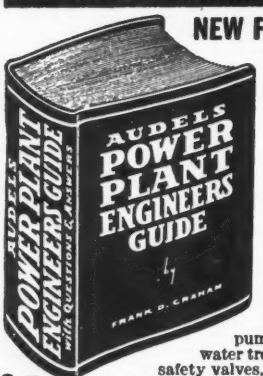

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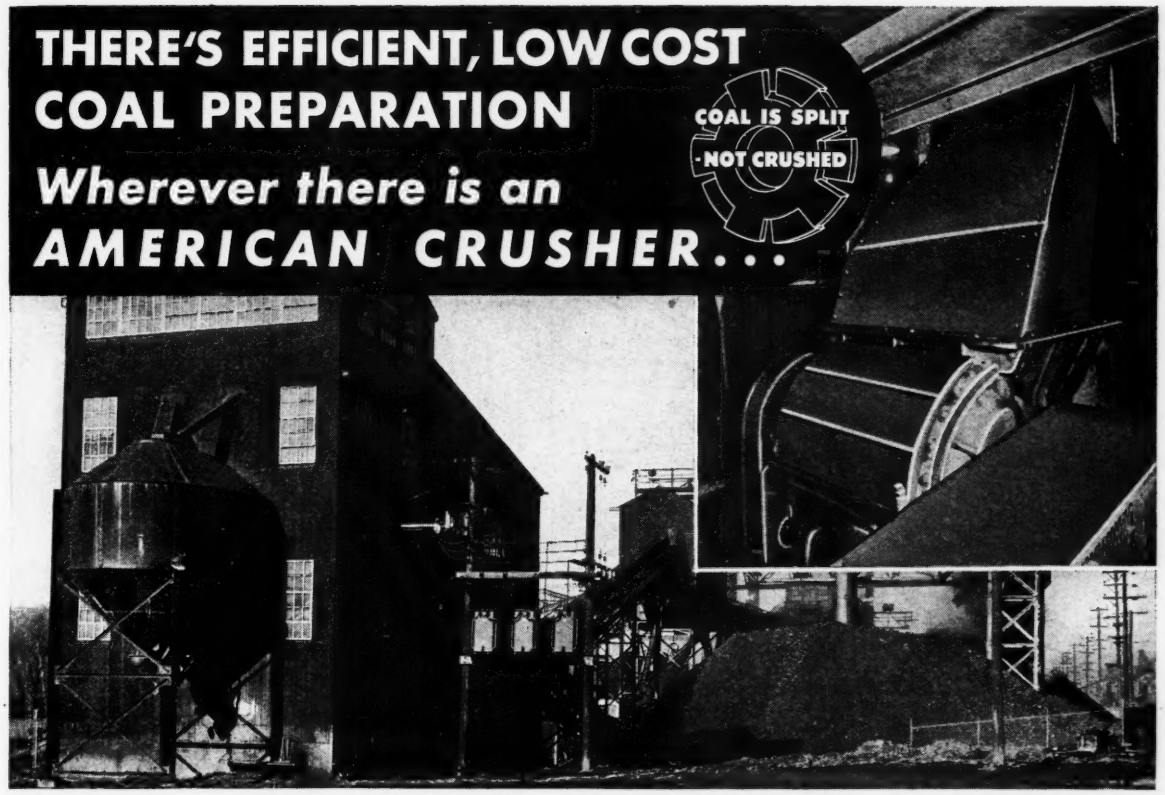
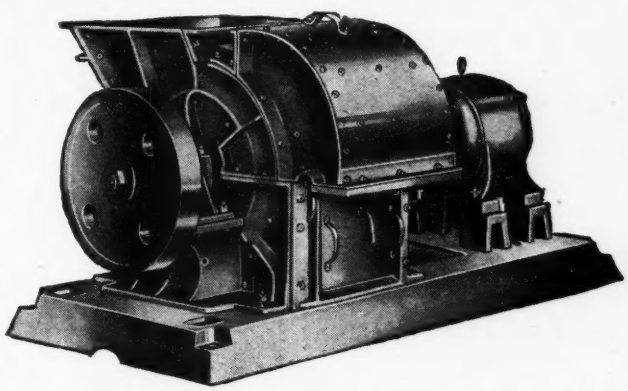


At the Windsor Power House Coal Co., Power, W. Va., preparation plant shown above, the American Rolling Ring Crusher Model 40S (in insert) is in daily operation reducing 5 x ¾" coal to —¾" at the rate of 230 TPH.

Throughout the country, in the many plants with American Crusher installations, you'll find efficient coal crushing resulting in efficient firing.

American Rolling Ring Crushers, with their patented shredder ring action which *splits coal instead of crushing it,* assures uniform sizing. Fines are controlled to a minimum or maximum and no oversize is passed. The crushed product is a constant yield of stoker or pulverizer size.

The total operating cost of Americans is less than 1c per ton.



The American "S" Crusher for power plants is a compact, complete crushing operation which is installed in minimum head room without extensive conversion and with no auxiliary crushing facilities.

There is an American Rolling Ring Crusher to fit your needs. Capacities up to 500 TPH.

Send for Bulletin "Crushing Coal at Less Than 1c Per Ton"

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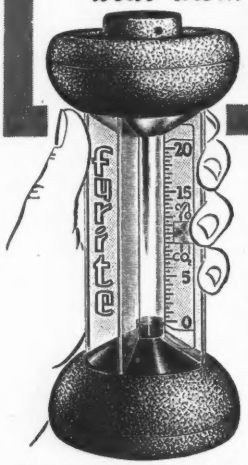
DETECT FUEL WASTE IN 40 SECONDS

with the... **FYRITE** CO_2 INDICATOR



The FYRITE makes accurate CO_2 analysis of the flue gases easy—and CO_2 percentage is the direct index of fuel wasted up the stack due to needless excess air being drawn into the furnace. The FYRITE is sturdy, spill-proof—accurate within ½ of 1% CO_2. No setting-up necessary; no valves, clamps, or leveling bottle. More than 13,000 are in successful use.

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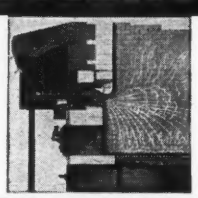

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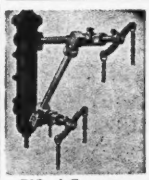

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FIG. 4-F

FIG. 13

FIG. 9

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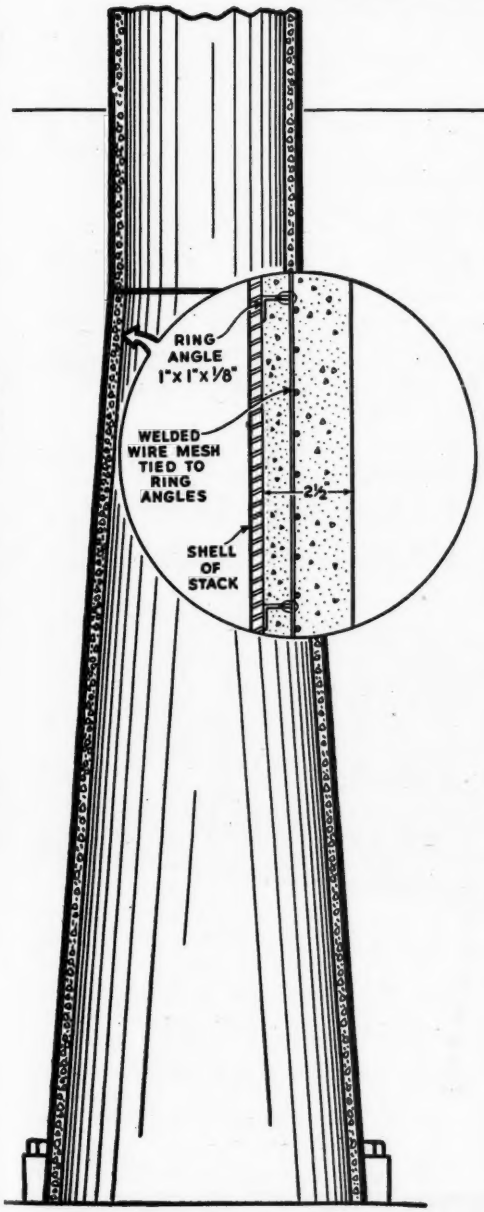

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A LUMNITE lining only 2½ inches to 3 inches thick gives full protection, while it allows maximum effective draft area. The efficiency of an old stack is increased; a new stack may be designed for greatest economy of steel.

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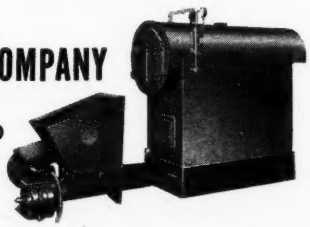

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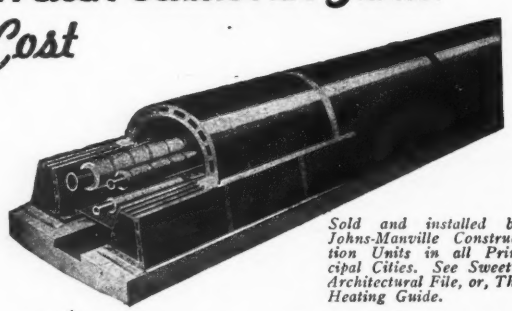

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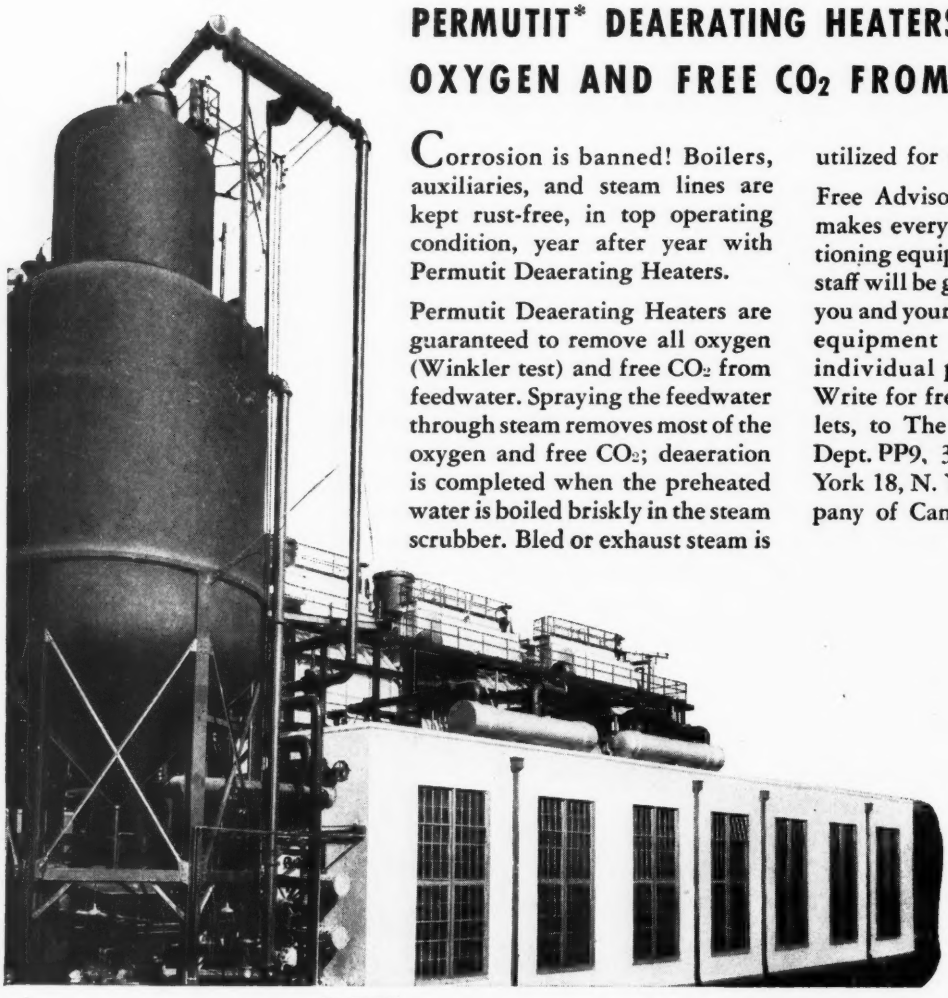

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